VOLUME XXV
NUMBER SIX

THE NATIONAL GEOGRAPHIC MAGAZINE

JUNE, 1914

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CONTENTS

16 Pages of Photogravure
The Land of the Montezumas

The Home of a Forgotten Race
WITH 43 ILLUSTRATIONS — EDWARD H. THOMPSON

Scenes in Mexico
WITH 30 ILLUSTRATIONS

Discovery and Invention
ALEXANDER GRAHAM BELL

Guardians on Land and Sea
WITH 16 ILLUSTRATIONS — WILLIAM JOSEPH SHOWALTER

Honors to Col. Goethals
Addresses by President Woodrow Wilson, Secretary of State Bryan, the German Ambassador, the French Ambassador, and Congressman James R. Mann.

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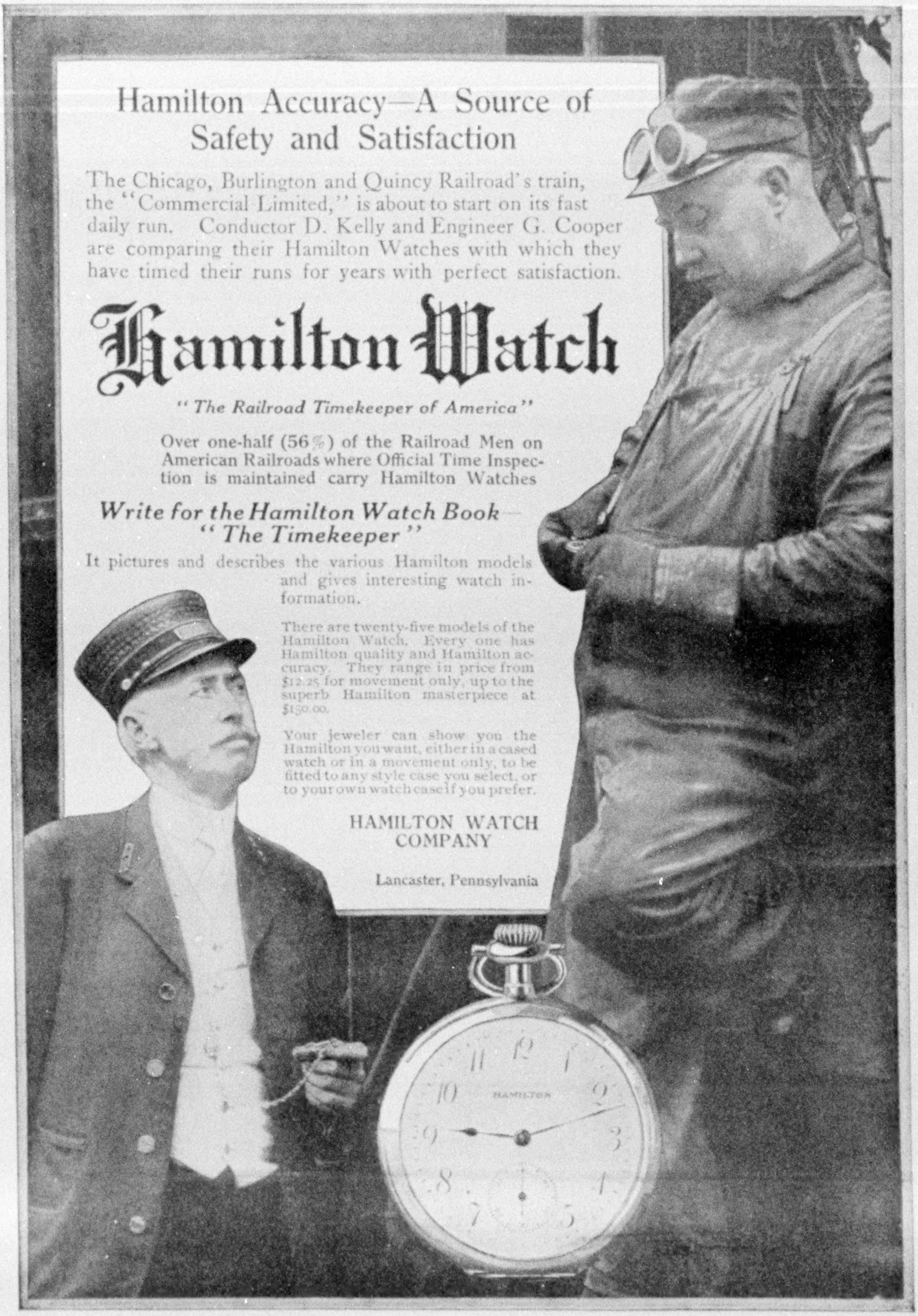

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The Chicago, Burlington and Quincy Railroad's train, the "Commercial Limited," is about to start on its fast daily run. Conductor D. Kelly and Engineer G. Cooper are comparing their Hamilton Watches with which they have timed their runs for years with perfect satisfaction.

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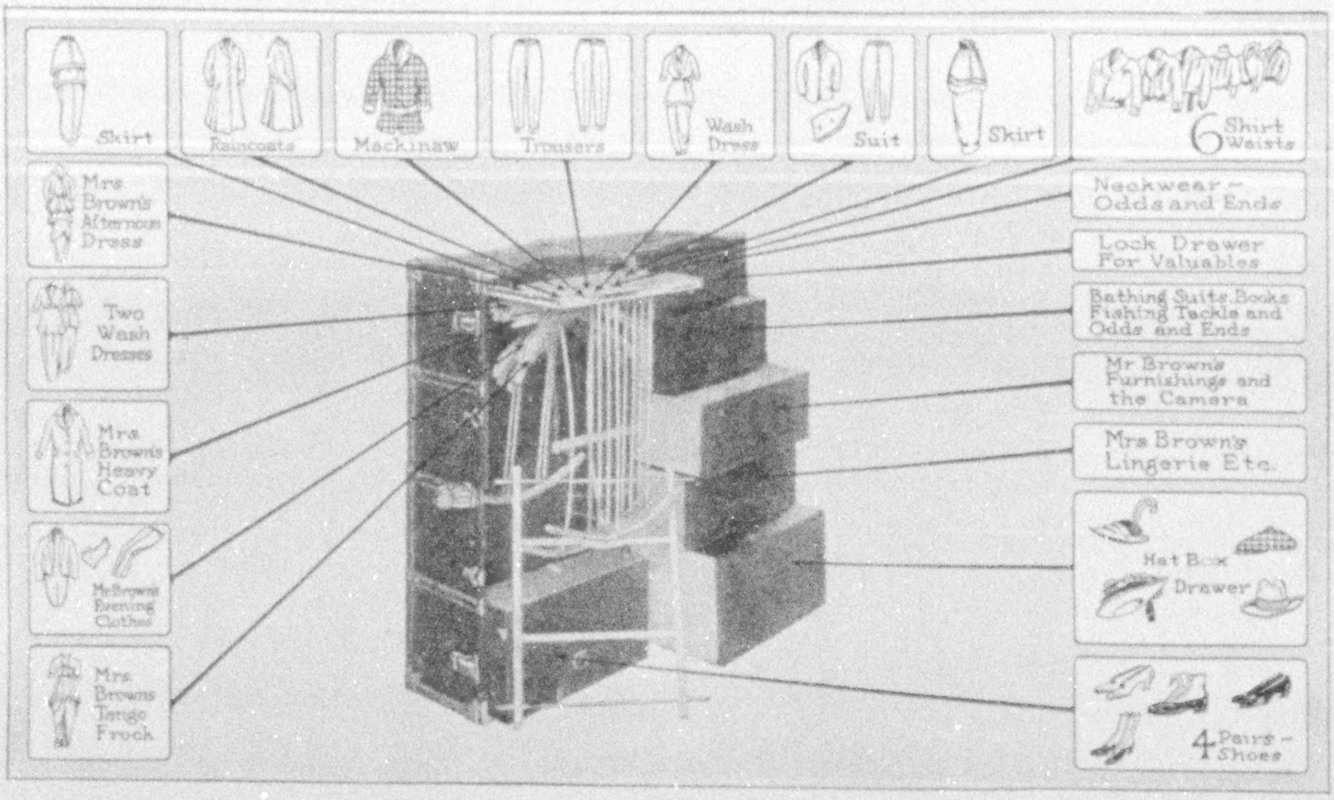
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(and save $4.10 in the Bargain)

Fan-tods!

You've had them. They come on the night before vacation. You gather up your things. You bring out your old-style trunk. You start to pack. You jam. You crowd. You squeeze. And still you have to lock up leaving out much you wished to take along.

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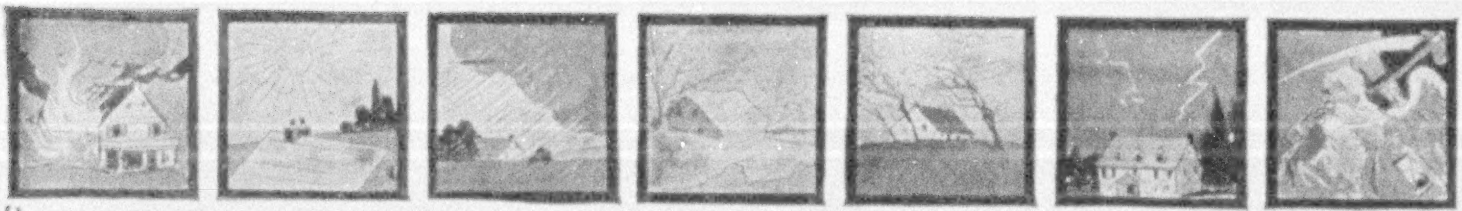

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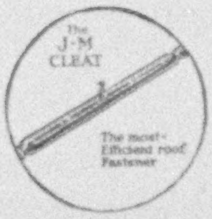
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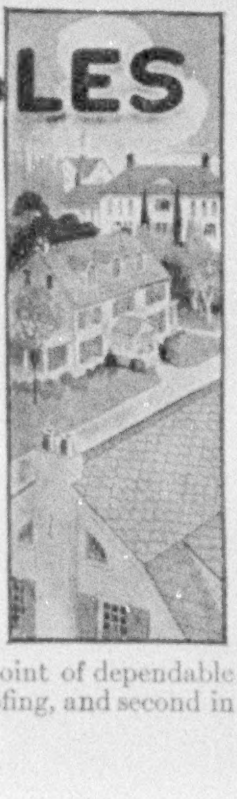
Lends an added charm to the appearance of the roof, is easily applied, and prolongs the life of the roofing.



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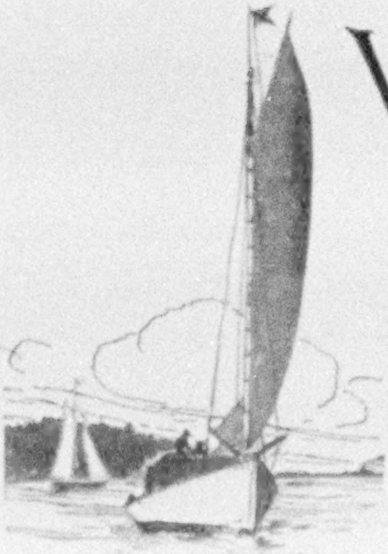

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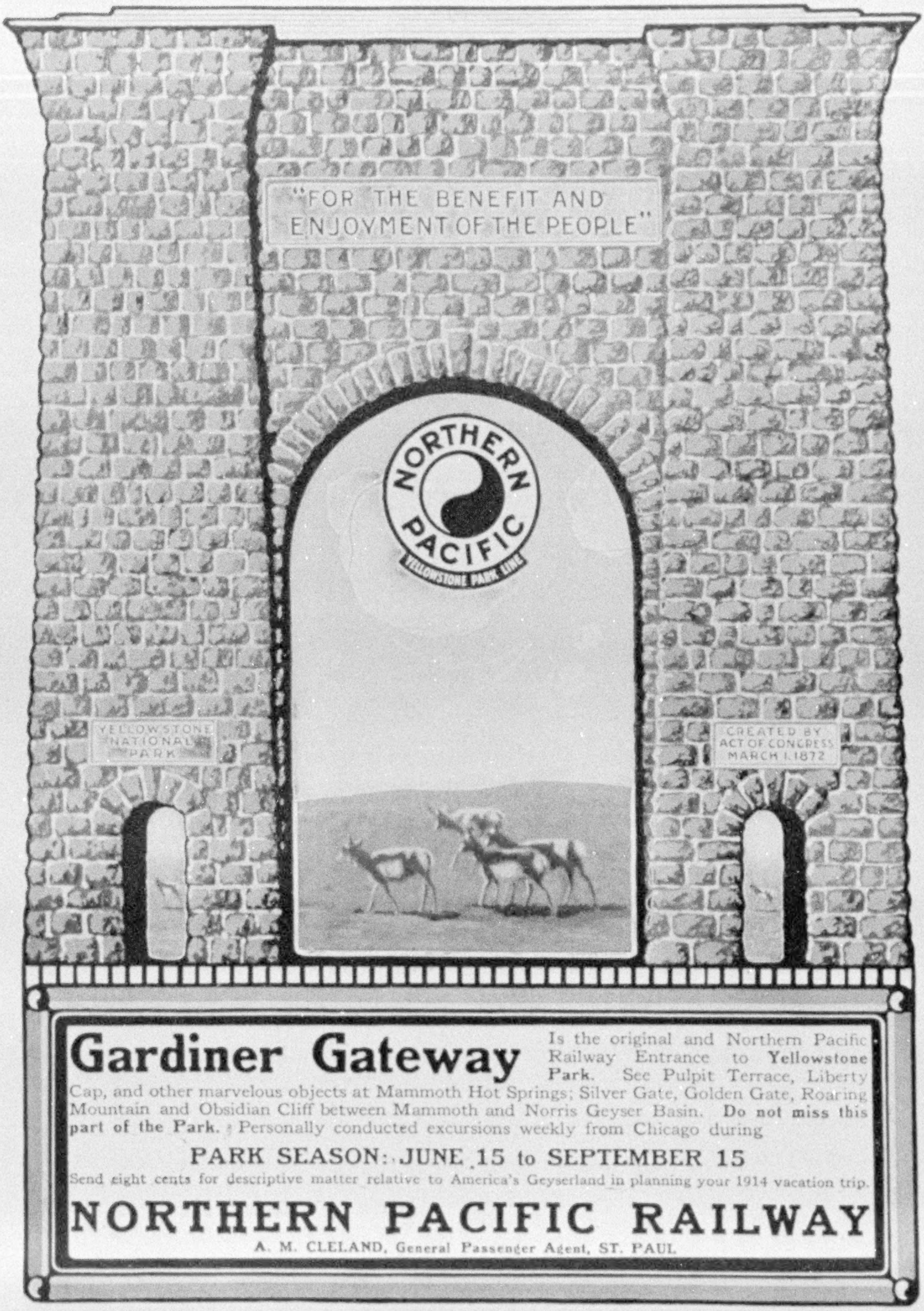
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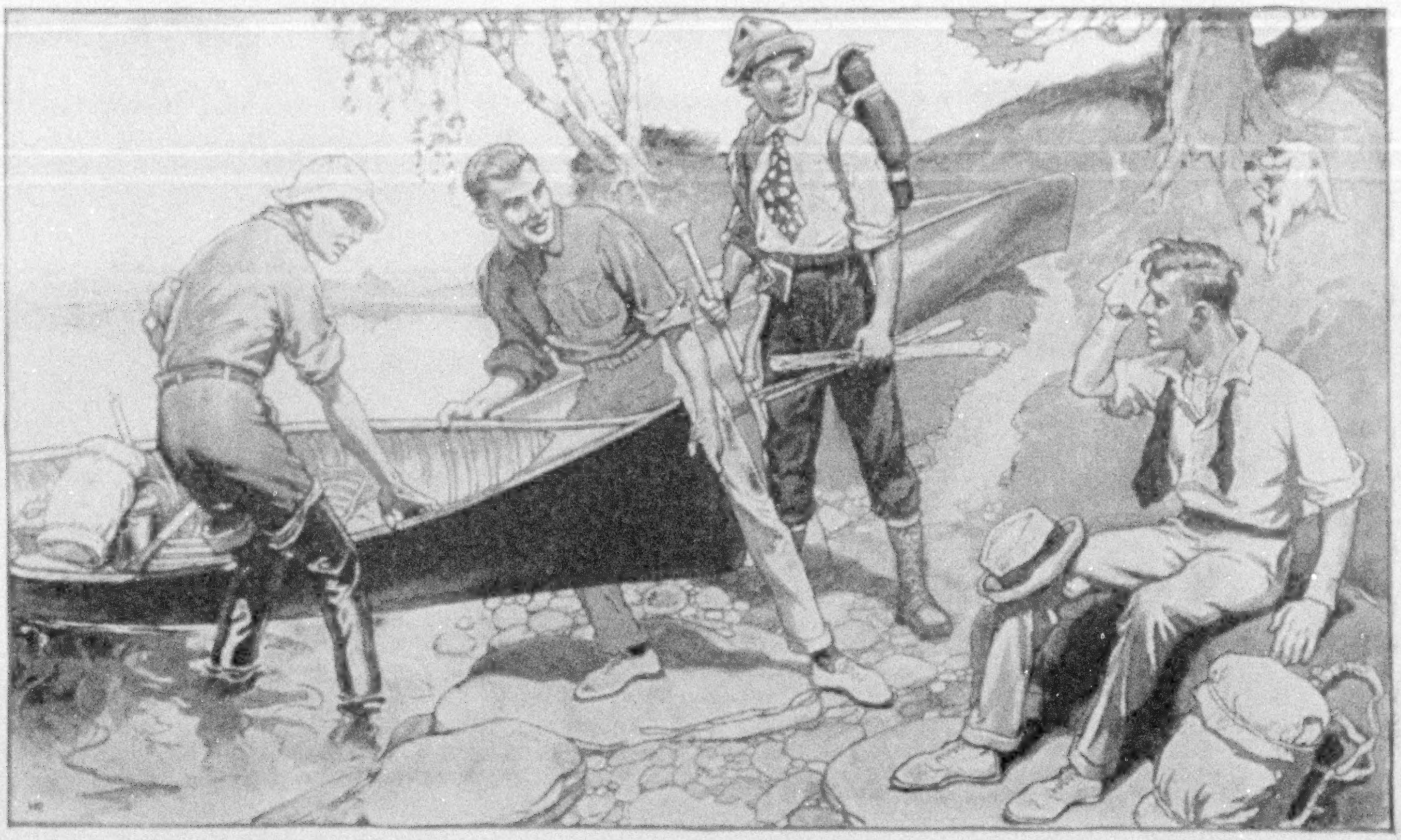

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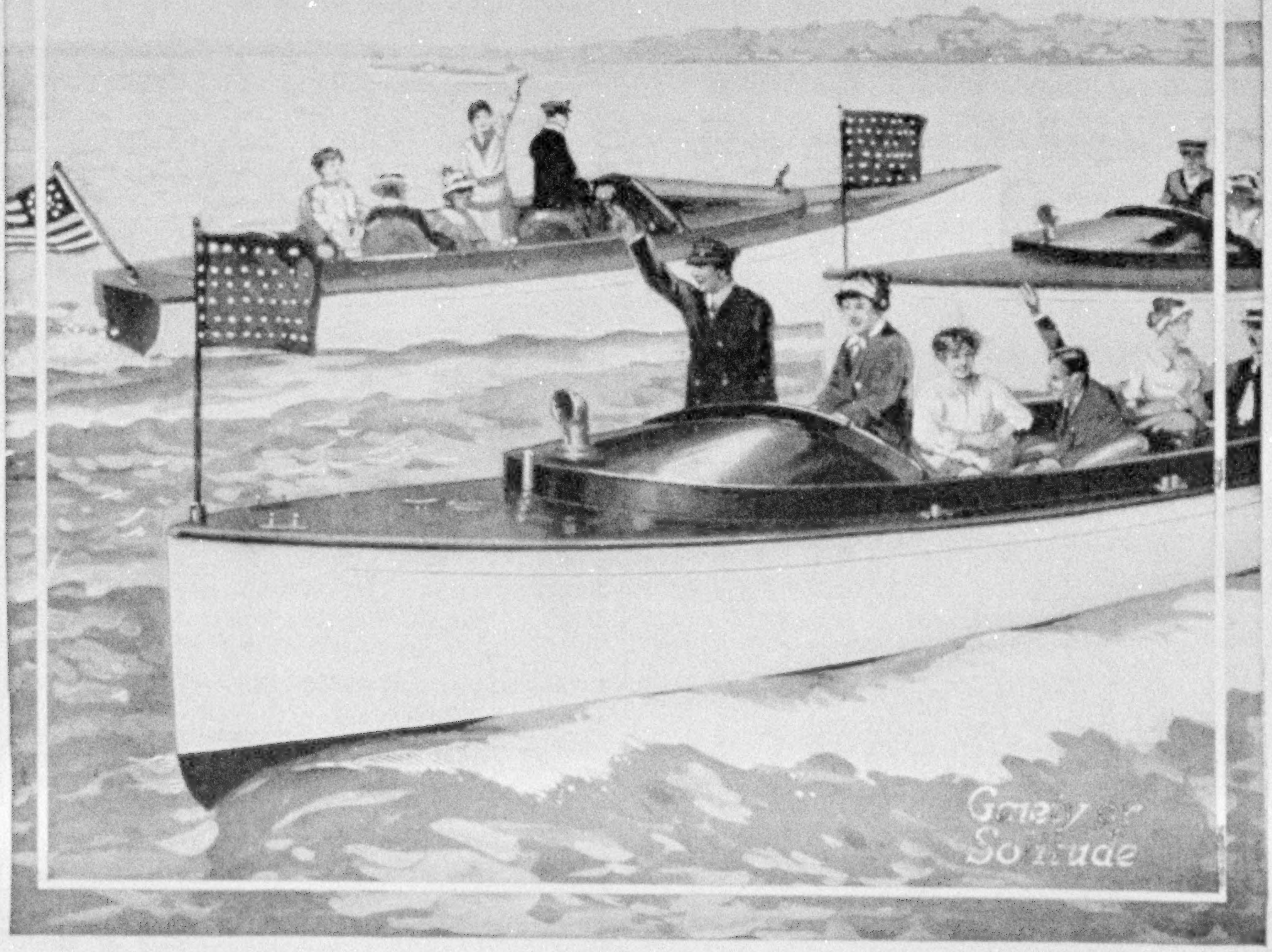

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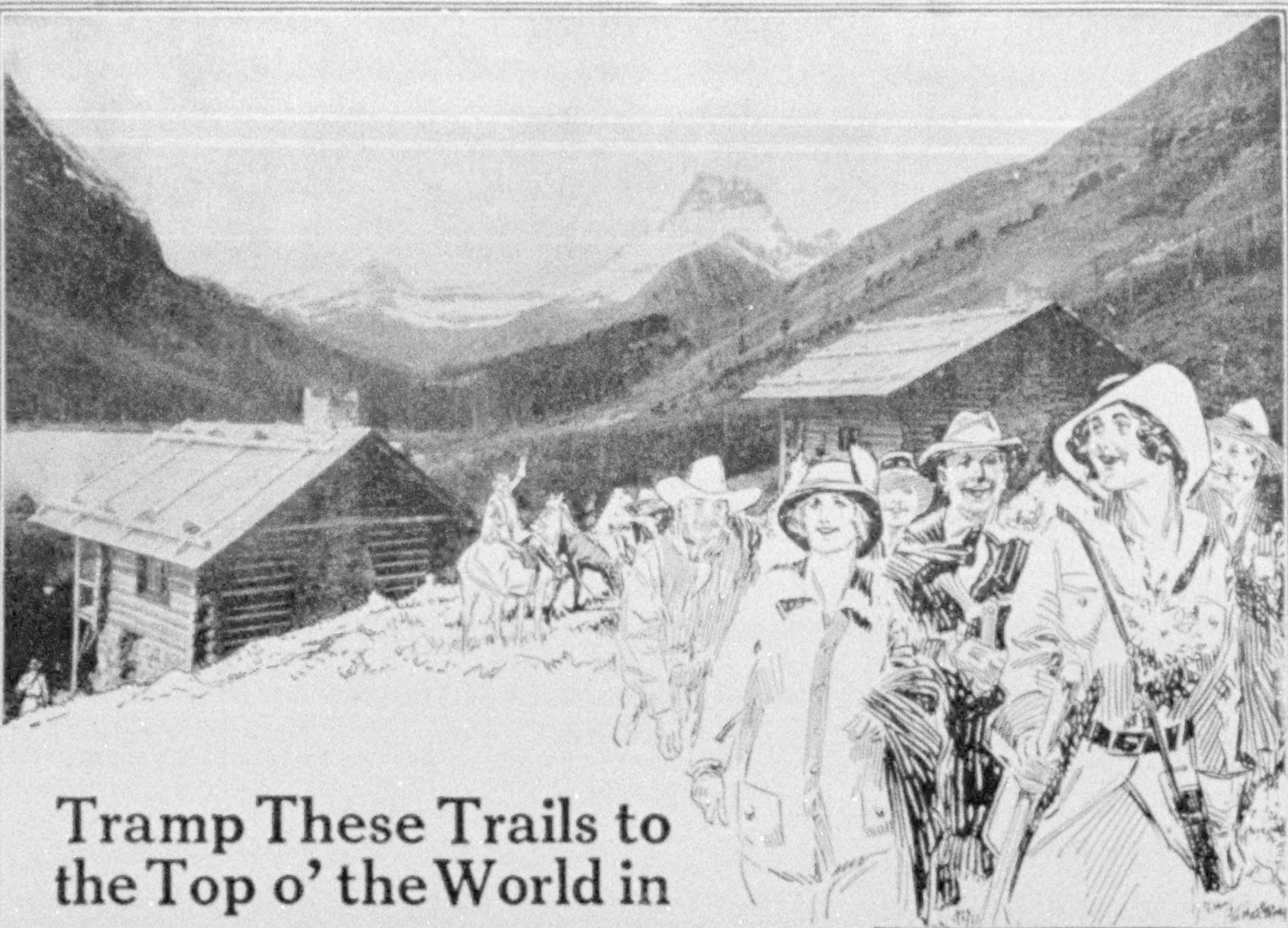

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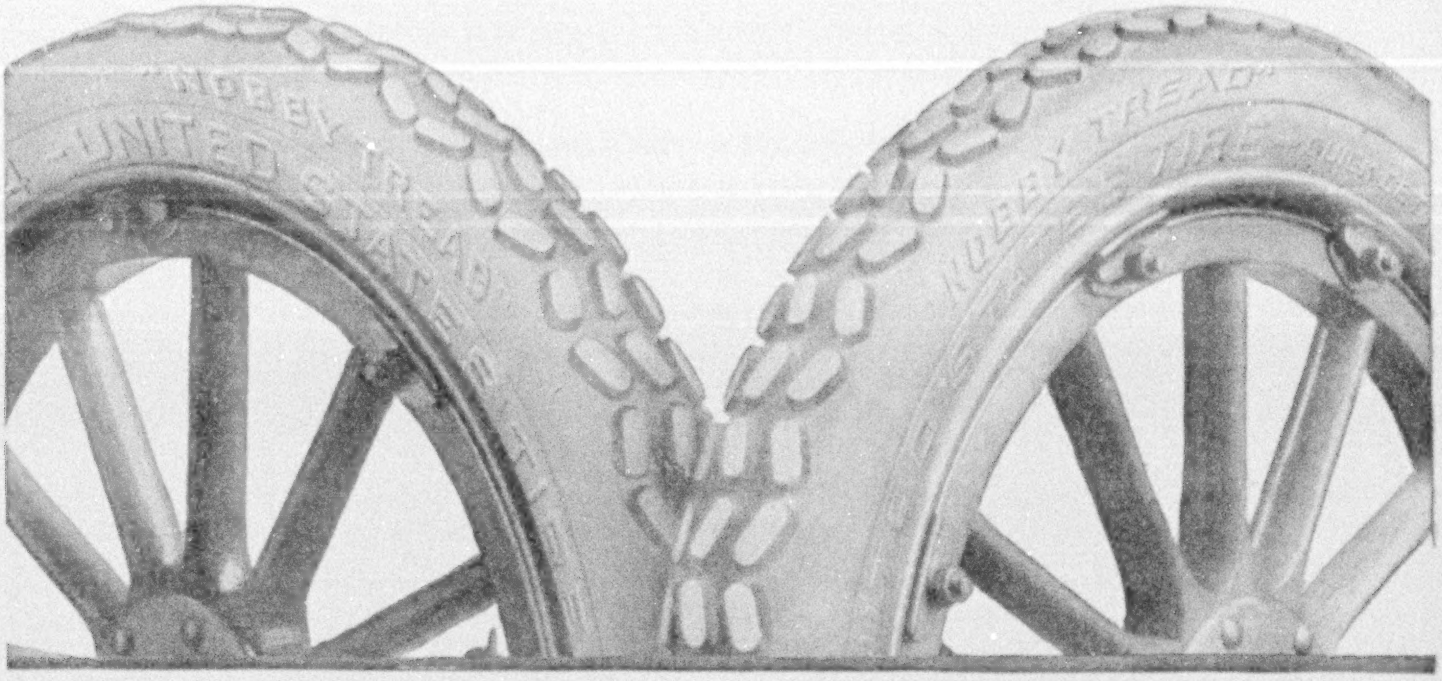

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Vol. XXV, No. 6 WASHINGTON June, 1914

THE
NATIONAL
GEOGRAPHIC
MAGAZINE

THE HOME OF A FORGOTTEN RACE

Mysterious Chichen Itza, in Yucatan, Mexico

By Edward H. Thompson

Formerly U. S. Consul at Mérida, Yucatan

THE ruined group of Chichen Itza, on the Peninsula of Yucatan, Mexico, covers a space of fully 3 square miles. Over all this wide territory are scattered carved and squared stones in countless thousands, and fallen columns by the hundreds, while the formless remains and outlined walls of huge structures fallen into ruin are seen on every side.

Seven massive structures of carved stone and adamantine mortar still tower erect and almost habitable. Their façades, though gray and haggard with age and seamed by time, sustain the claim that Chichen Itza, in the Americas, is one of the world's greatest monuments of antiquity.

The heart of most of the cities of antiquity was a castle or temple; in this great American monument the heart was a castle and a temple—both in one.

As this is a popular descriptive article rather than a technical one, I shall try to restrain my always present desire and inject only enough figures to give adequate conceptions of size and distance.

A terrace as broad and level as a plain is raised 10 feet or more above the surrounding surface, built up with rubble and finished with a lime cement—hard, white, and durable. On this man-made plain was built, among other structures, a pyramid of nine terraces (see page 586), each faced with inlaid paneled stonework and well finished.

On each of the four inclined faces of this pyramid a stairway was built 111 feet long and 28.7 feet wide, with 104 steps rising from the base-level up to the crowning platform.

Each of the four angles of the pyramid is formed by the undulating body of a great stone serpent. Descending from the crowning platform, each undulation of the body marks a gradient, a terrace plane, while on each side of the northern stairway a serpent head, with wide-open jaws, carved from a single mass of limestone, rests on the plane beneath. A strong man cannot hope to lift the smallest stone that goes into the making of this serpent body.

THE CASTLE TEMPLE

All this is simply of the base, the preparation for and the leading up to the building proper, the Castle Temple (see page 586). This temple is not large, measured by the standards of the present day, or even by that of those ancient builders. Like the heart of the human body, it was not large but important.

Built on the level platform that crowned the pyramid, it is itself only 43 feet by 29 feet, with a narrow level space around it on the platform's outer edge barely wide enough for two to walk abreast in safety.

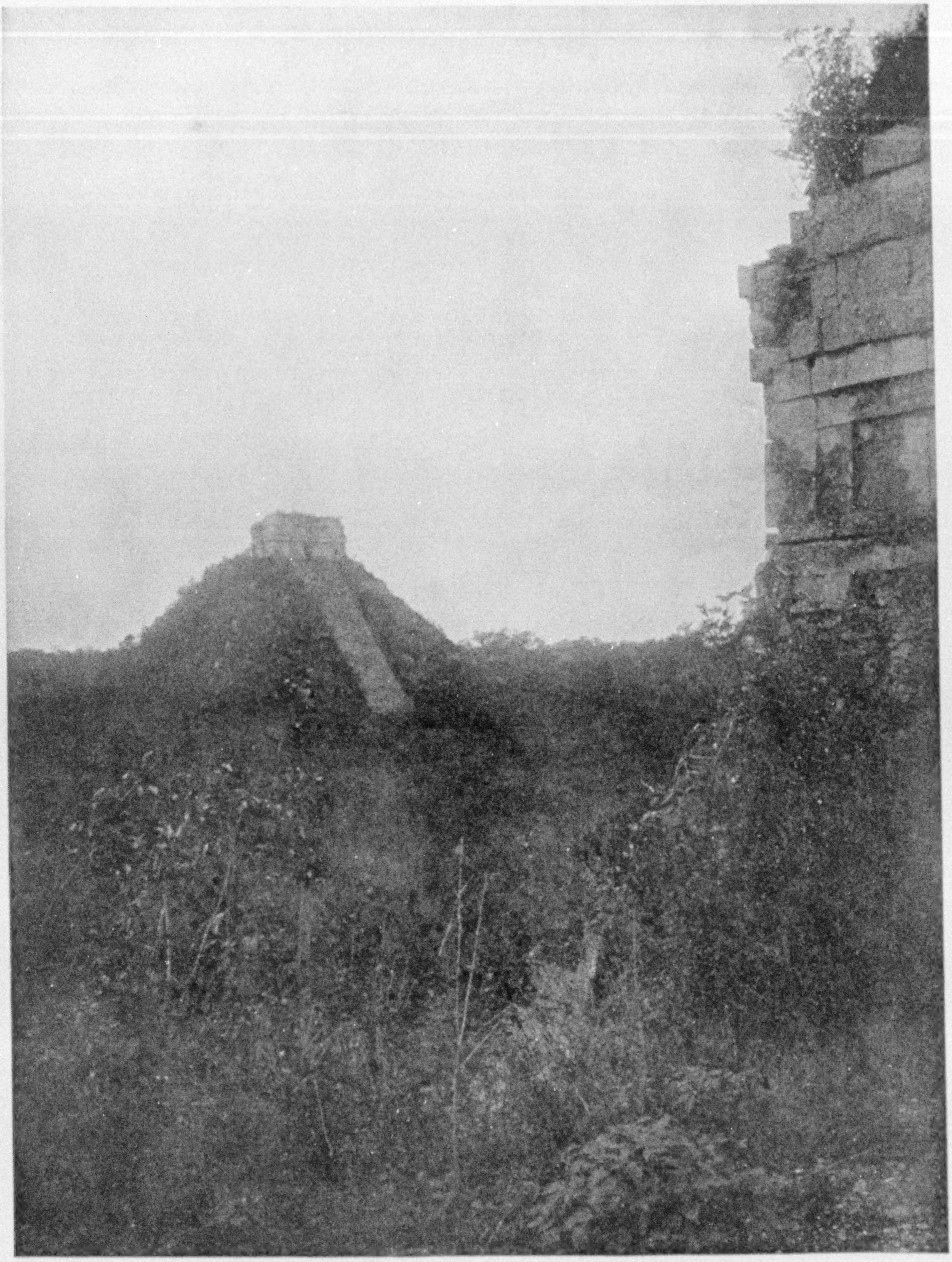


Photo by Edward H. Thompson

THE GREAT PYRAMID TEMPLE OF CHICHEN ITZA, IN YUCATAN, MEXICO

"On the roof are ornaments of carved stone cut in curious angles and placed like battlements. These probably served as shelters to the fighting men and protection to the priestly watchers of the stars and planets as they traced the celestial orbits and read the omens this revealed" (see text, pages 585 and 587).

On the north, facing a few degrees east of north, is the Ceremonial Stairway, with its two great serpent heads leading up the pyramid to the entrance of the sanctuary.

Thick stone pillars, fashioned always in the conventionalized serpent form, sustain the carved and paneled façade above the entrance to the outer corridor and inner chamber, the sanctuary of the temple. In the semi-gloom of this sanctuary are two square pillars of stone, each supporting massive twin beams of thick sapote wood richly carved. These in their turn help to support the strange triple-vaulted roof of the chamber (see page 588). Sapote wood, like the East Indian teak, is as strong and almost as durable as stone.

Wooden beams, stone pillars, and entrance posts are all carved in low relief (see page 589). Symbols and human figures, some in mask and bearded, and all clothed in ornate regalia, with strange weapons and the flowing plumes of the quetzal, cover their paneled surfaces.

The symbol of the feathered serpent—the body of the rattlesnake, covered with the plumage of the quetzal bird—was to this old civilization what the Cross was to the Christian and the Crescent to the Saracen.

Under this symbol the culture hero *Kuk-ul-can* (Feathered Serpent) of Yucatan, *Quetzacoatl* of the Aztecs and earlier people, was first reverenced, then deified and worshipped.

Most of the carvings on stone surface were painted, but the wooden lintels, carved or plain, were apparently dull finished in their own natural color—a rich red brown.

On the south, east, and west a single high-vaulted but narrow chamber was formed [-shaped, with sapote lintels and carved doorways facing each of the stairways.

Large serpent masks, each flanked by sunken paneled squares, are the only ornaments of these three façades, and, except that on the western façade, are placed directly over the entrances. The mask of this western façade is several feet to the south of the entrance.

This was not a random work, neither did the conformation of the structure make this lack of symmetry a necessary fault.

Is it true that the ancient builders of the East were wont to leave one stone missing or one carving misplaced in an otherwise perfect work because only the Supreme One should produce perfection?

On the roof are ornaments of carved stone cut in curious angles and placed like battlements. These probably served as shelters to the fighting men and protection to the priestly watchers of the stars and planets as they traced the celestial orbits and read the omens thus revealed.

THE HOUR OF SUNRISE

The writer stood upon the roof of this temple one morning last December just as the first rays of the sun reddened the distant horizon. The morning stillness was profound. The noises of the night had ceased and those of the day were not yet begun. All the sky above and the earth below seemed to be breathlessly waiting for something—just waiting. Then the great round sun came up flaming splendidly, and instantly the whole world sang and hummed. The birds in the trees and the insects on the ground sang in a grand Te Deum.

Nature herself taught primal man to be a sun-worshipper, and man in his heart of hearts still follows the ancient teachings.

A gentle breeze sprang up, and then he seemed to be upon a sea-bound rocky promontory, high above all things. The calm sea surface stretched away to where the sky-line met it, and there they fused into an opalescent something, seemingly born of the union of a rainbow with the white sea-foam.

The sun rose higher and the sea of mist dissolved into nothingness. In its place was an ocean of verdure, with a foam of bright blue flowers, the bloom of the jungle morning glory. As he descended the steps worn by the sandal tread of a thousand years, he thought: "Can this world show a more beautiful sight?"

From the northern edge of the level terrace at the base of the temple pyra-

XUM

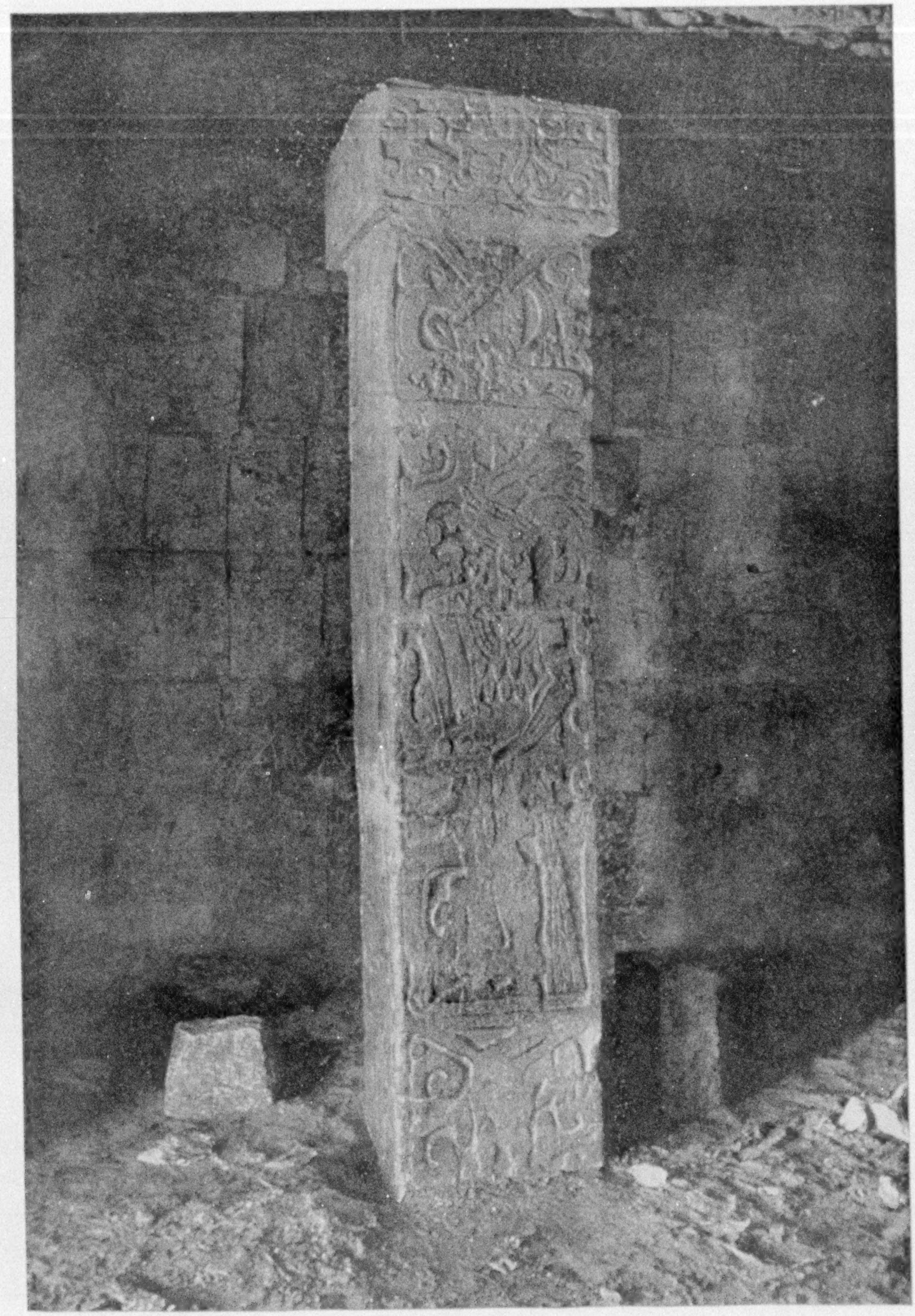


Photo by Edward H. Thompson

IN THE SEMI-GLOOM OF THIS SANCTUARY ARE TWO SQUARE PILLARS OF STONE, EACH SUPPORTING MASSIVE TWIN BEAMS OF THICK SAPOTE WOOD, RICHLY CARVED

Sapote wood, like the East Indian teak, is almost as strong and durable as stone. Note the warrior with his elaborate head-dress carved on the column (see page 587)

XUM

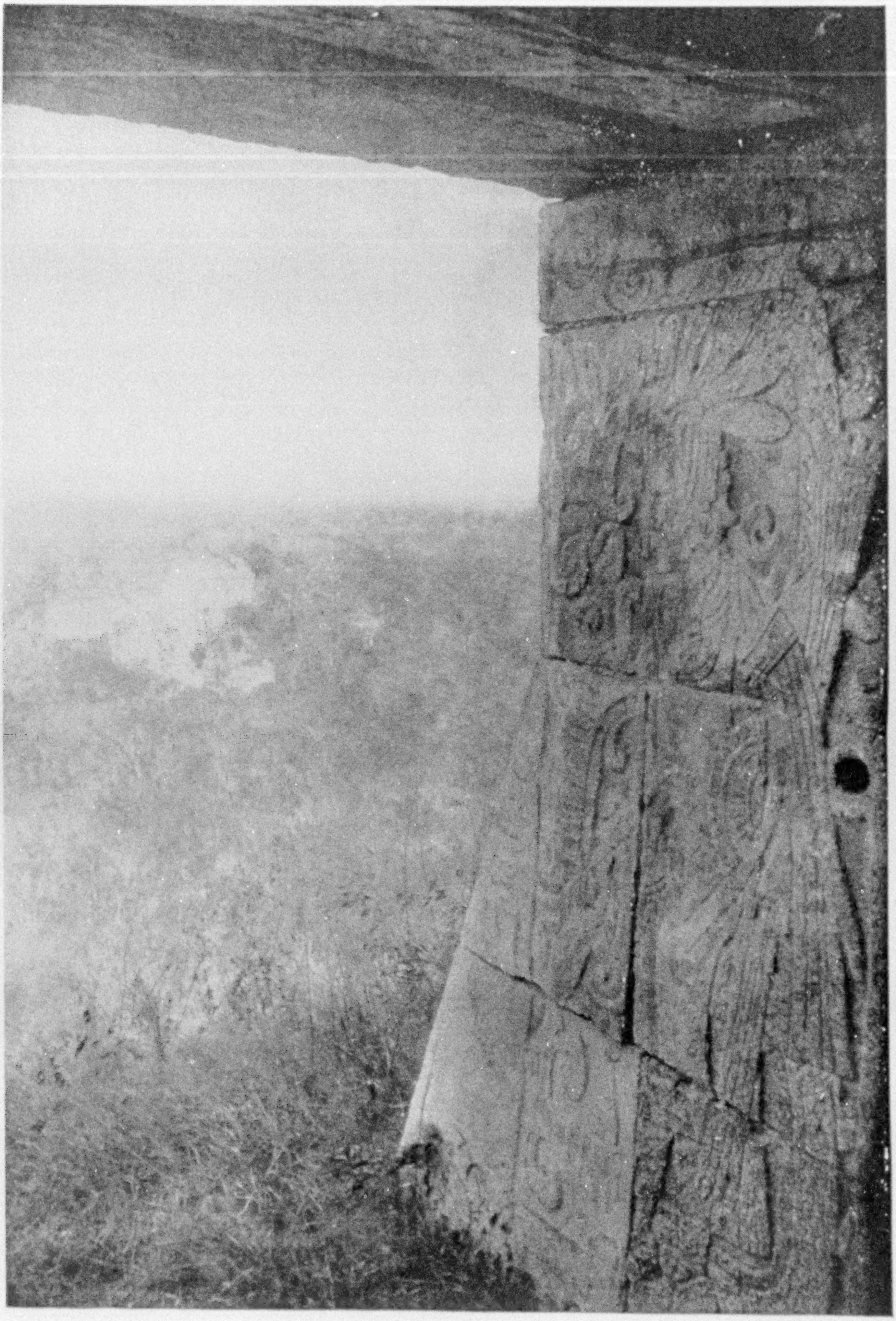


Photo by Edward H. Thompson

WOODEN BEAMS AND ENTRANCE POSTS ARE ALL CARVED IN LOW RELIEF

"Wooden beams, stone pillars, and entrance posts are all carved in low relief. Symbols and human figures, some in mask and bearded, and all clothed in ornate regalia, with strange weapons and the flowing plumes of the quetzal, cover their paneled surfaces" (see page 587).

XUM

mid a raised causeway, 25 feet wide and macadamized, extends northward 300 yards or more to the Sacred Well.

THE SACRED WELL INTO WHICH PRISONERS AND MAIDENS WERE THROWN

This was the Sacred Way, and in times of pestilence and drought solemn processions of priests, devotees with offerings, and victims for the sacrifice wound between the snake-head columns down the long, steep stairway of the temple and along the Sacred Way to the dreadful Sacred Well (see page 591). The weird music of the flute and the shrill notes of the whistle mingled with the droning boom of the sacred drum as the priests, the devotees with their offerings, and the nobles grouped themselves on the brink of the well.

Then from the platform beside the shrine the offerings from far and near were tossed in, and finally the prisoners of war and beautiful maidens, drugged with the sacred ambrosia Balche, were thrown into the jade-colored waters as expiatory offering to an offended deity.

Could this deep old limestone water-pit, the Sacred Well, be given a tongue and made to tell what it had seen, what world romance could equal it!

Several hundred feet to the west of the Castle Temple, and on the same terrace with it, rest two great parallel moles of solid masonry (see page 592), each 275 feet long, 34 feet wide, and 25 feet high.

Between these moles is the Ceremonial Court. This level cemented space was probably the theater for the performance of certain rites and games of a ceremonial character, like the Aztec game dedicated to Tlaloc.

This belief is borne out by the fact that at a distance of 6 feet from the level upper surface of the mole two great rings of stone were firmly fixed by means of tongues into the perpendicular wall surface directly opposite each other.

One of these rings had either fallen out of its place by its own weight, or more probably was dug out by native honey seekers, and now lies prostrate, but whole, on the ground beneath. The other yet stands out boldly from the sheer wall surface, and the entwined serpents carved on its annular faces are still clearly visible.

To the north and south of these great moles are the half-ruined remains of two small temple structures (see page 594). Shrine-like, they seem to guard the entrance to the Ceremonial Court; but they themselves, their carved walls and columns time worn and beaten, are fully exposed to the wear of the elements.

THE TEMPLE OF THE TIGERS

On the southern end of the eastern mole rests an edifice, like a casket holding jewels, that in time, as the fact becomes known, will be in itself the object of distant pilgrimages.

It is known as the Temple of the Tigers (see page 595) from the zone band of handsomely designed, artistically executed jaguars that, alternating with shields, ornaments the southern face.

Of course, it is understood that the term "tiger" is a misnomer as applied to the great Felidæ in America; the jaguar and not the tiger is meant. The term "tigre," meaning tiger, was probably first carelessly given by Spanish adventurers to the jaguar from Asia, and the name was thus wrongly perpetuated in America.

The entire front of the Temple of the Tigers has disappeared. Fractured and wedged apart by the growing tree roots at the apex of the roof, the overweight of the richly carved façade toppled it over into the space beneath, where it still lies in a formless mass.

Two large serpent columns, with open jaws and bulbous teeth, are still in place. These once helped to sustain the fallen façade, and probably served as the massive fulcrum that tossed the mass of stone and lime free from the platform in front down on the level floor of the Ceremonial Court. These, like all the other serpent columns, are carved in the conventionalized crotalid shape and covered with the conventional quetzal plumes.

The square end pilasters of the outer entrance to the inner chamber are entirely covered with sculptures in low relief. Like those upon the pilasters and columns of the Castle Temple, the prin-

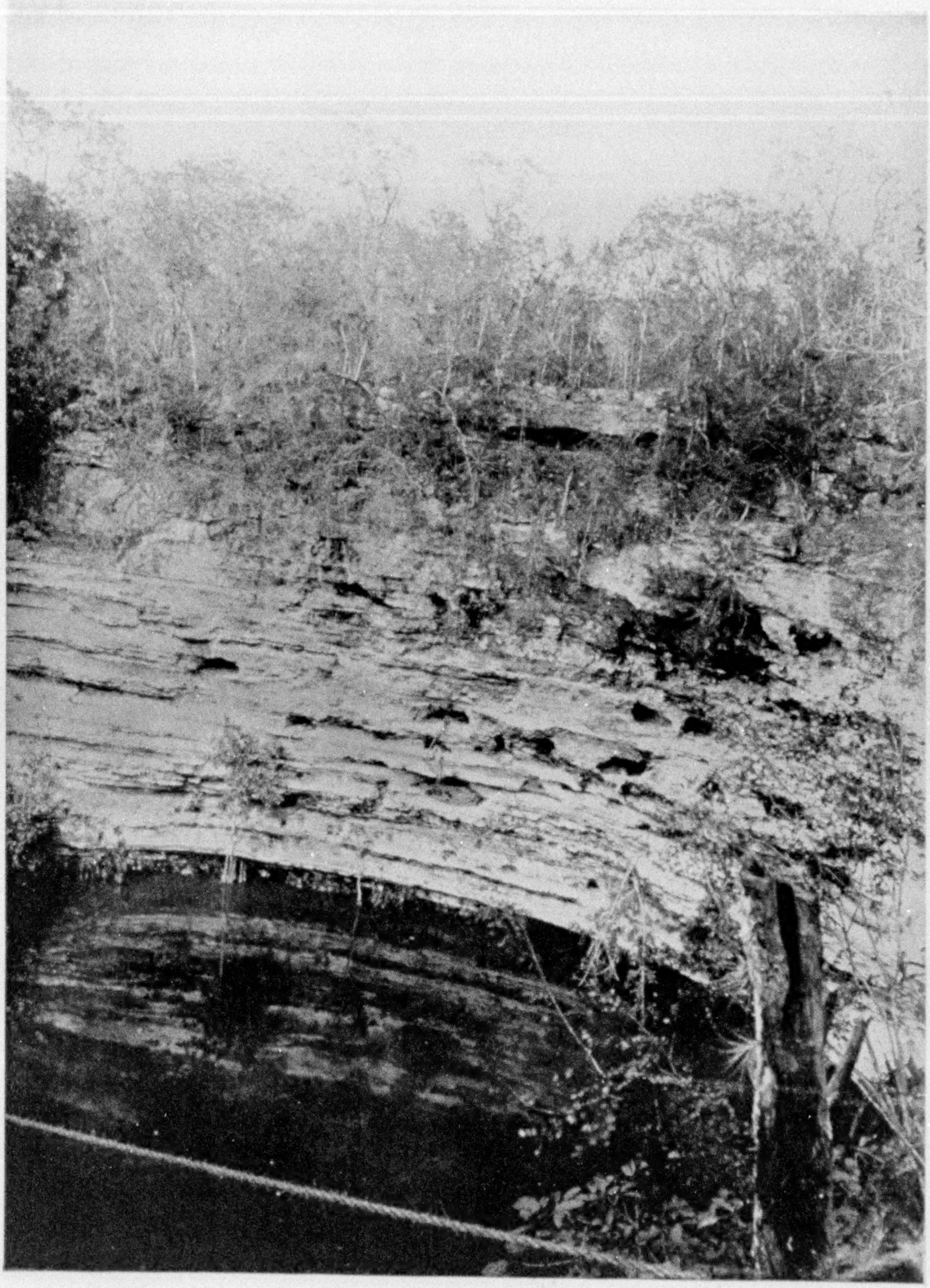


Photo by Edward H. Thompson

THE SACRED WELL INTO WHICH PRISONERS OF WAR AND BEAUTIFUL MAIDENS WERE THROWN

Could this old limestone water-pit, the sacred well, be given a tongue and made to tell what it has seen, what world romance could equal it!

XUM

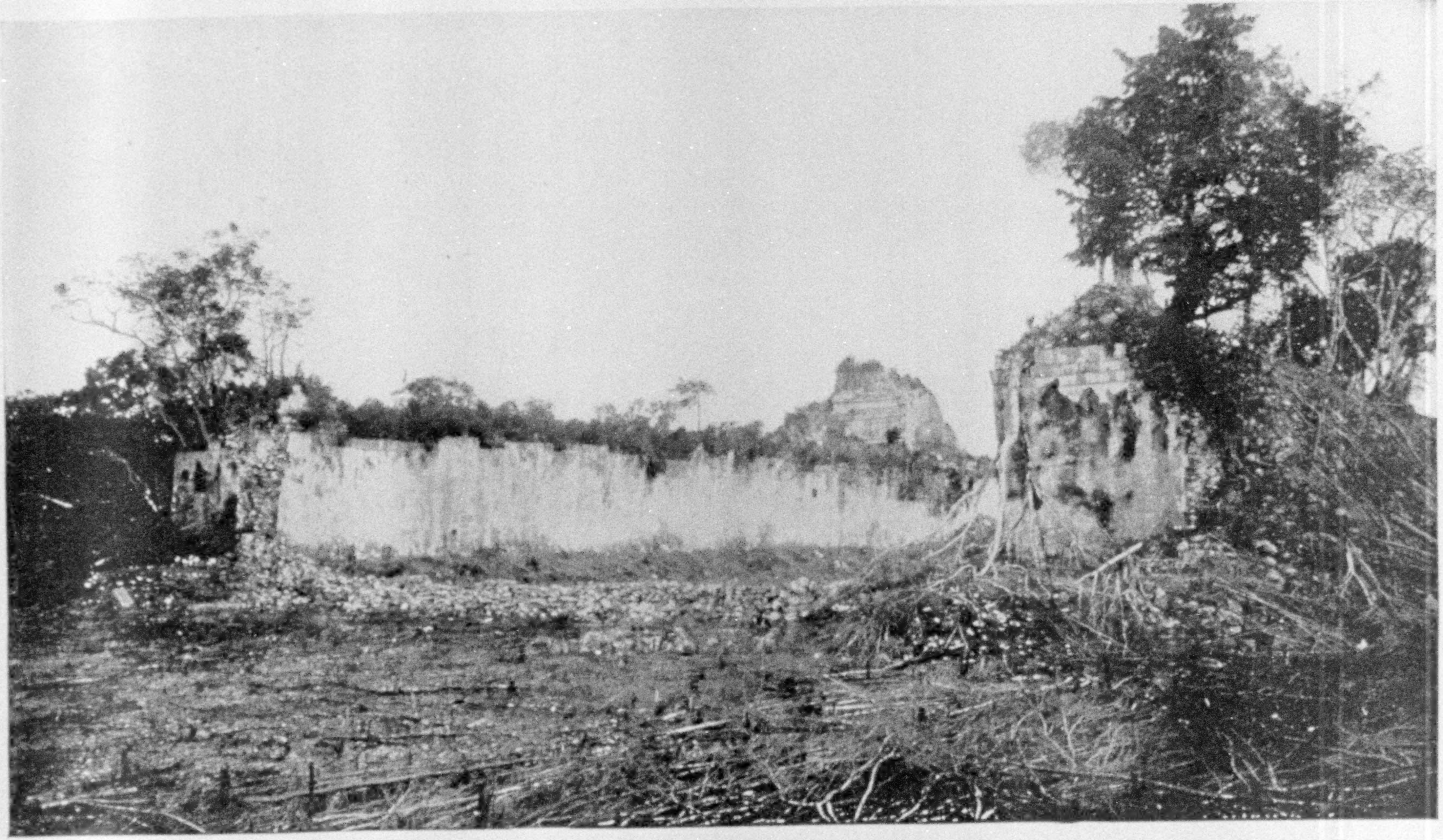


Photo by Edward H. Thompson

THE GREAT PARALLEL MOLES OF SOLID MASONRY WHICH FLANK THE CEREMONIAL COURT

"This level, cemented space was probably the theater for the performance of certain rites and games of a ceremonial character, like the Aztec game dedicated to Tlaloc" (see text, page 590) cipal motive on each panel is a human figure elaborately costumed and brilliantly painted.

MAYAN MURAL PAINTINGS

The wall surface of both chambers bear traces of having been once covered with mural paintings. Those on the walls of the outer chamber have become entirely obliterated by the erosive action of the elements. Those on the walls of the inner chamber are in part obliterated by the excreta of bats, and still more by the vandal hand of man.

Enough yet remains to make this little chamber the repository of the best-preserved examples of the mural paintings of this ancient Maya race at present known.

The best-preserved portion represents a battle scene. The attacking party, with atlatls, spears, and shields, are seemingly assaulting a city or some large center. Above the battlefield can be seen tier upon tier of houses, and amid them are women in agonized postures, looking down upon the fighting warriors.

To one side is the symbolical figure of *Kuk-ul-can,* with lightning-like yellow flames issuing from his mouth, the sign of defiance and also of war. Many other scenes and portions of figures are depicted, but the battle scene is the clearest of them all at present. The figures are done in a clear, easy style, vigorous and true.

Belonging to this same temple, but on a lower level and built against the eastern wall, is a chamber 22 feet long by 10 feet wide and 15 feet high.

The front of this chamber also is destroyed, and in practically the same way as that of the upper chamber. A portion of the end walls and a large part of the rear still remain upright (see page 596), and the superb wall sculptures they hold upon their surface are fortunately still left for study and comparison.

Clear-cut features, well-worked details, artistically executed and well carried out, show the skill and spirit of these ancient artists. The carvings clearly represent the performance of some religious rite or ceremonial dance. Entwined about the series of masked and conventional figures are the serpent symbol, that of the sun and apparently that of rain and water.

Description is nearly useless in such cases as this; only photographs or drawings can adequately represent the work.

The figures were originally painted in the conventional colors, with the ever-present deep red background.

Portions of the two richly carved square pillars that once helped to sustain the fallen front, and between them a rigid conventionalized "tiger," seemingly a kind of ceremonial seat, complete all that is now visible of this chamber.

Half ruined as it is, the Temple of the Tigers is a treasure and a boon to students of the Maya civilization.

A MAYAN PRISON

South of the Temple of the Tigers lies the beautiful little structure known to the natives as the Chichen Chob, the Prison (see page 598), probably the most perfect existing unit of ancient Maya architecture. The pyramid supporting and the stairway leading up to it are almost intact, the angles and faces of the edifice itself almost perfect.

Within the chambers some of the wooden cross-beams are still in place, the mural paintings on the hard-finished walls are evident, although nearly effaced; but the long band of well-carved hieroglyphics that extend entirely across the wall opposite the doors is as perfect and delicately clear as if carved but yesterday.

To the southeast lies the Round Tower (see page 600), a strange structure, unique in plan and outline. This edifice rises like a turret, 40 feet and of equal diameter, from near the center of a terrace, 20 feet high, 220 feet long by 150 feet wide.

HUMBOLDT'S SURPRISE

Its purpose is at present unknown; but from its construction, annular chambers, winding stairway, and the position of its outlooks and outlets I believe it to have been an observatory, an edifice devoted to the study of the celestial bodies. It is known that the ancient American calendar system was so accurately developed

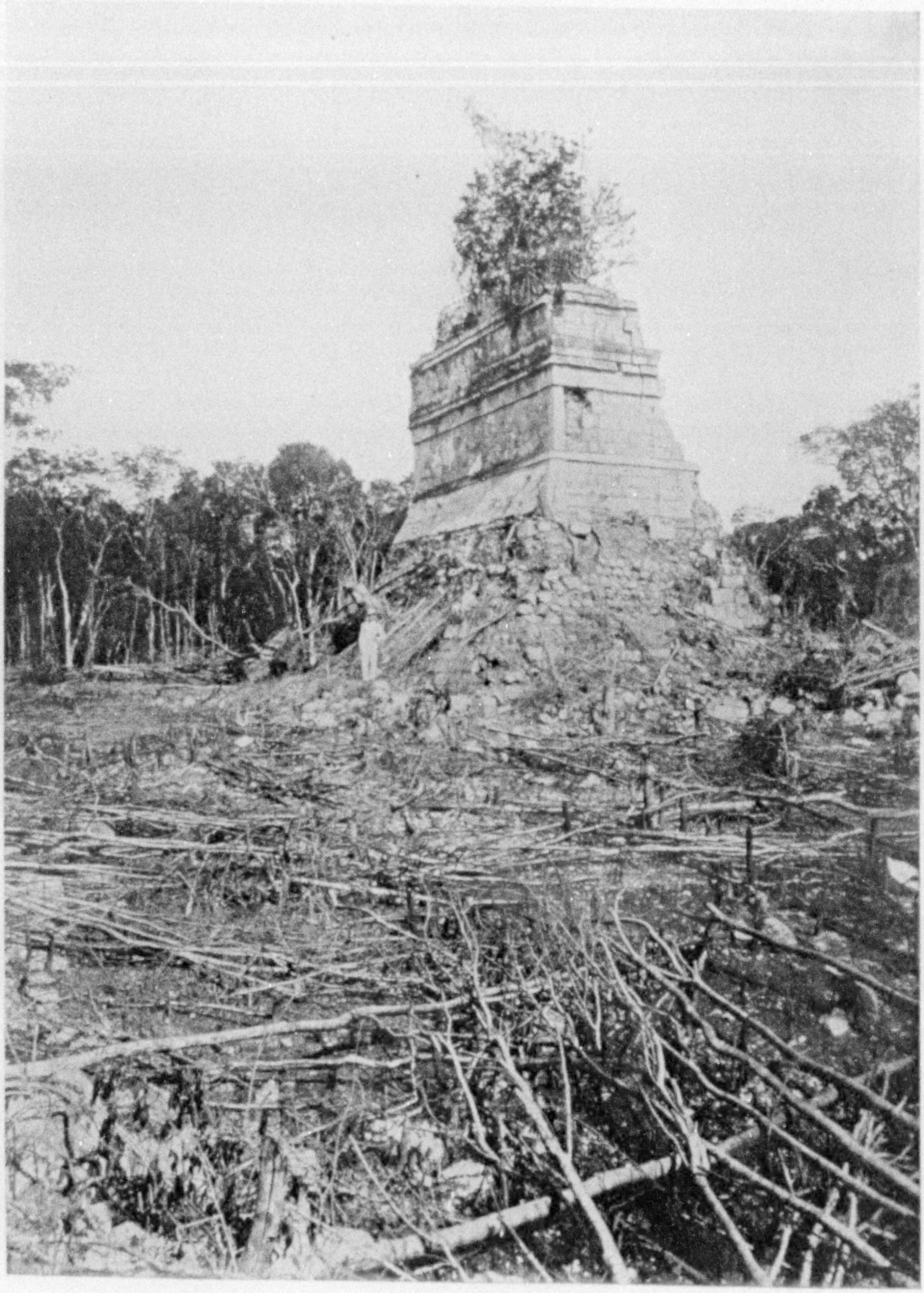


Photo by Edward H. Thompson

ONE OF THE TWO SMALL TEMPLES WHICH SEEM TO GUARD THE ENTRANCE TO THE CEREMONIAL COURT (SEE PAGE 590)

XUM

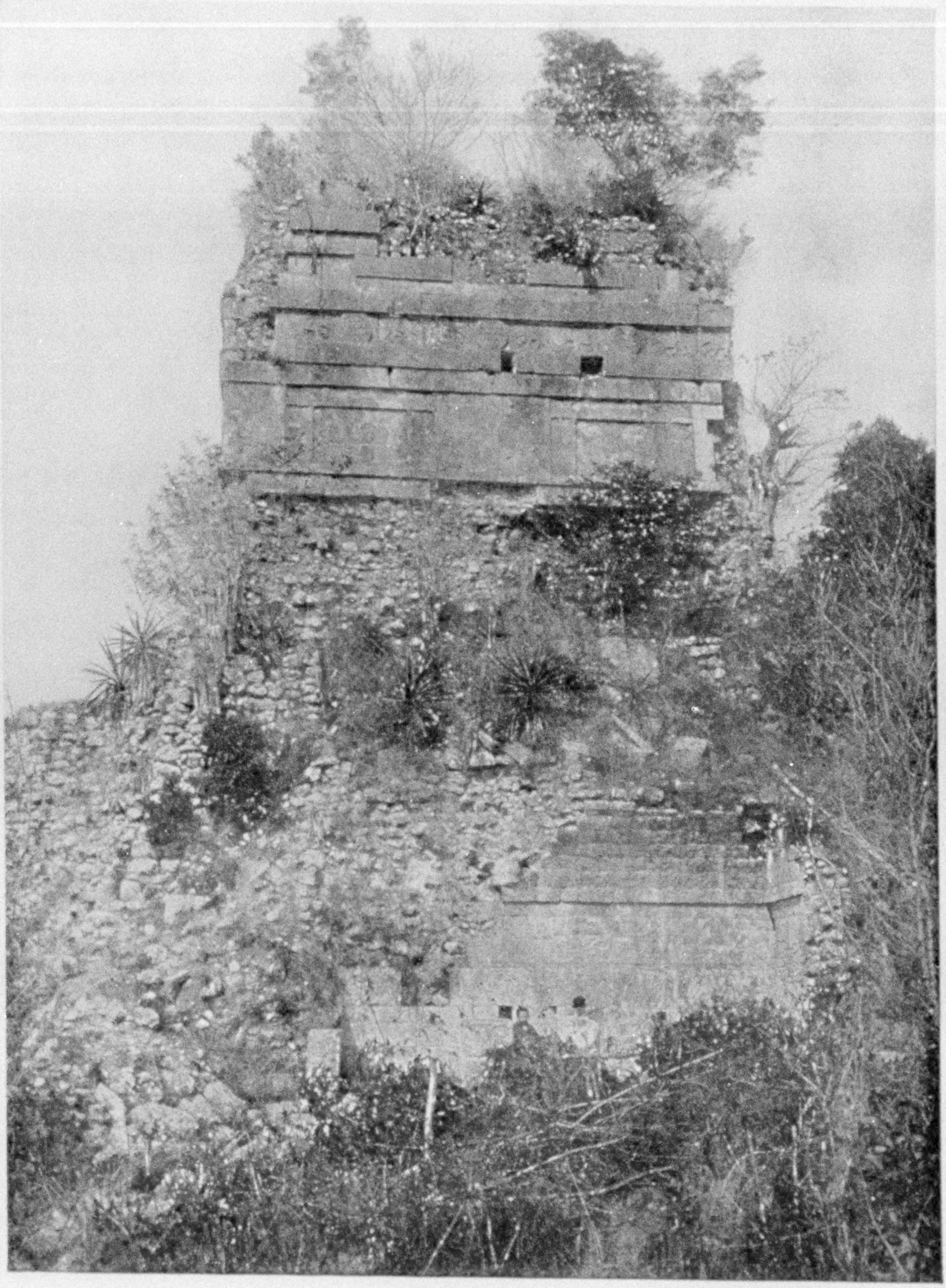


Photo by Edward H. Thompson

THE TEMPLE OF THE TIGERS

The band of handsomely carved jaguars, alternating with shields, can be discerned near the top of the building (see page 590). "Half ruined as it is, the Temple of the Tigers is a treasure and a boon to students of the Maya civilization" (see text, page 593).

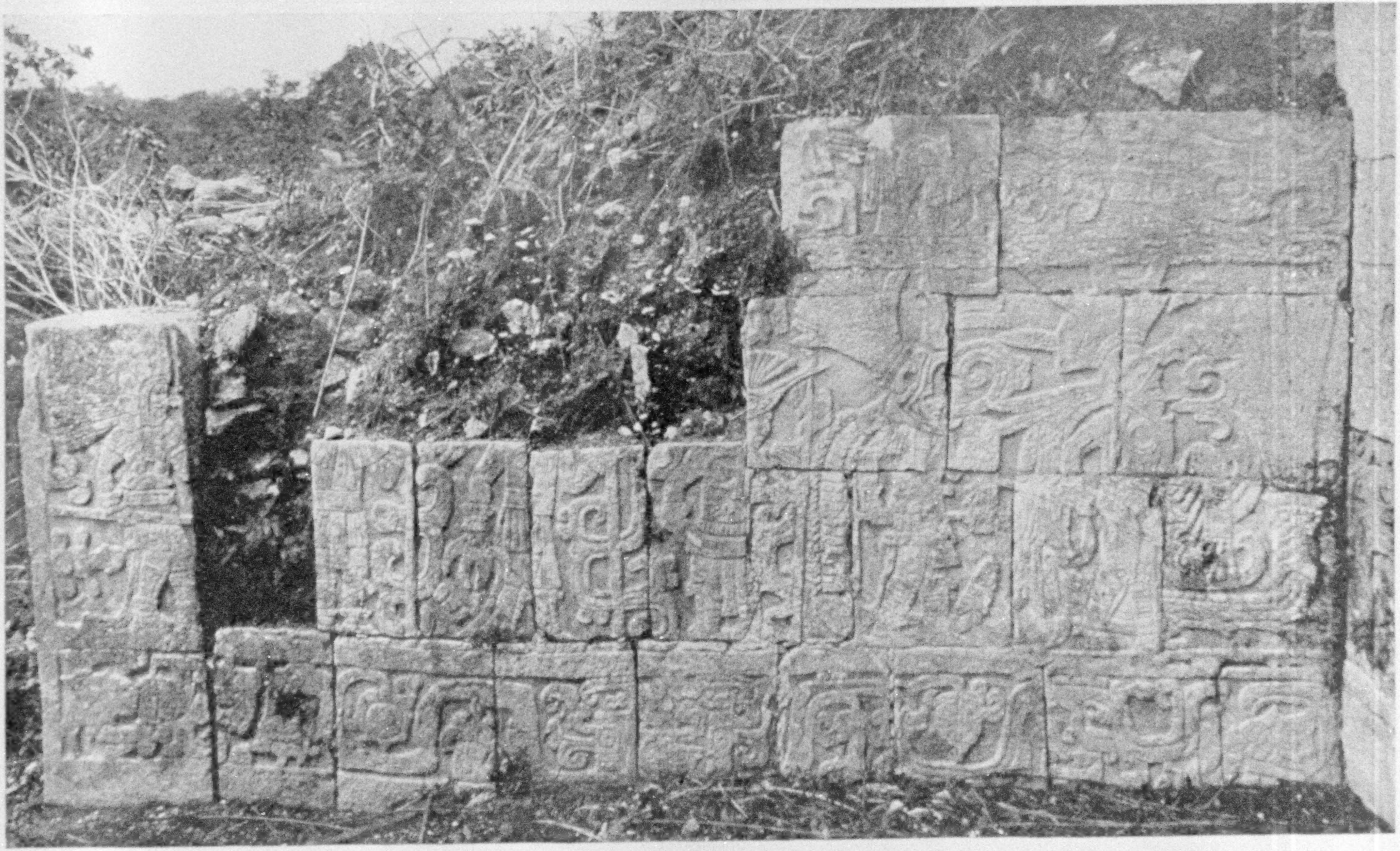


Photo by Edward H. Thompson

THESE SUPERB WALL SCULPTURES REPRESENT THE PERFORMANCE OF SOME RELIGIOUS RITE OR CEREMONIAL DANCE that Alexander Von Humboldt was for a time incredulous of its native origin.

The learned ones, the wise men among these people, were astronomers, not mere star-gazers, and there are those among the Mayas at the present day that have a surprising native knowledge of the celestial geography, as well as of curious properties of certain roots and herbs on the earth beneath.

The present conical form of this edifice, the shape of its chambers, and above all the peculiar inner stairway winding around a solid center, have caused the natives to call it, in their vernacular, "The House of the Snail," and this name in its Spanish dress clings to it now. As the *Caracol* (Snail) it is best known to the people of the region, and under this name it is shown to the curious and the visitors from afar.

THE "NUNNERY"

Nearly half a mile to the south of the Castle Temple rises the majestic pile of the "Nunnery" (see page 602). How far this name accurately indicates the original purpose of the edifice is not known; but we do know that among these ancient people a certain social organization existed, resembling in a modified form the societies of monks and nuns.

How much or how little of truth is in the name we may not know, but the edifice itself is probably the most ancient of all the structures now standing. How old no one knows; but the fact is evident that the central portion of the structure was old and time worn before the pitted surface and dulled angles were buried in the plastic mass of the newer masonry. Then in time this, too, was hidden under the present walls, new and clear lined then, but now gray and seamed by time and the elements, and this is a land where the ice never forms, the frost never rises, and dryness is more evident than dampness or moisture.

The façades of these later portions of the great mass of stone and lime are wonderful examples of carved stonework and ancient American symbolism. I doubt if, taken as a whole, their equal exists. The photographic views show this in a measure, and only in a measure.

The true beauty of the carvings and the perfect proportions of the structure can never be fitly shown until the debris that now hides the base and destroys the true symmetry of the edifice is removed. This work should be done by competent direction under supervision of the government.

Two small one-storied edifices, in the nature of detached wings, are on the right and left of the building proper.

One, known as "La Iglesia" Church, is still quite perfect, and the symbolical figures encrusted on its richly worked façade have long been objects of study to the student and of curiosity to the profane.

The other is a still smaller structure of ordinary design and no apparent points of special interest.

A wide, steep stairway, with the very narrow steps and risers common to the work of sandal-wearing people, leads up to the important second story. This portion of the structure sets back from the face of the lower one, thus leaving an open level space of some 30 feet wide, broken in front half way by the stairway leading up to the third story.

The lateral northern face of this upper second story has two true entrances into perfect chambers and four large recesses in the front walls that are either blind doorways or once true entrances into chambers formerly existing in the original structure, but later filled up to make a solid foundation for a third story directly above. When this was done the doorways remained as simple niches, and over these a flying buttress (see page 603) was thrown as a stairway to the newer structure above. This is my hypothesis, subject to modifications that future investigations may make necessary.

The stone lintels over every entrance, existing or blind, built into this face of the end walls are covered with handsome, still legible glyphs. Clearly legible indeed, but as unreadable as a sealed book.

Undeciphered and mysterious, they are the pleasure and despair of those who seek to solve the problems that they hold.

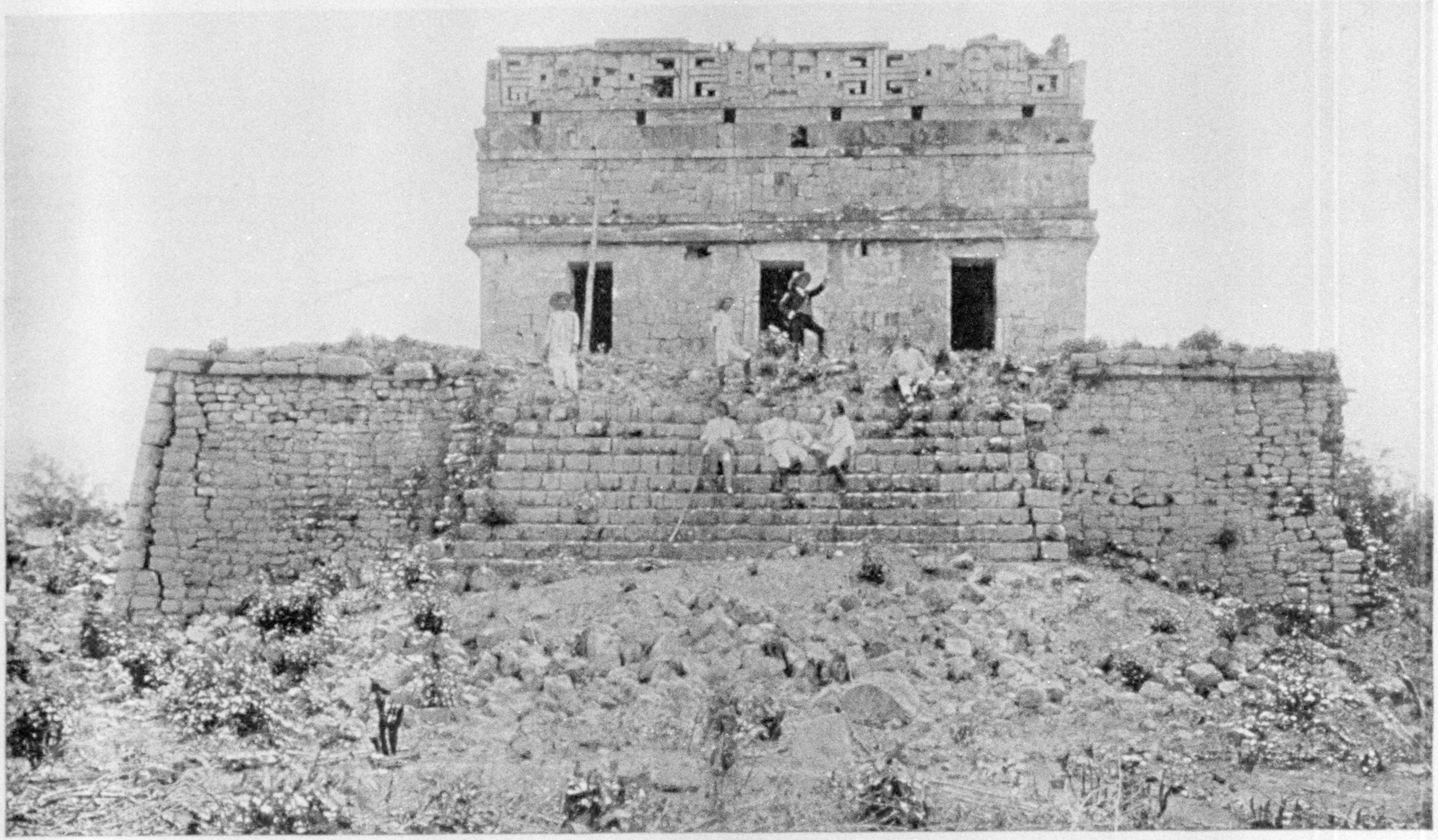


Photo by Edward H. Thompson

THE PRISON OR CHICHEN CHOB, PROBABLY THE MOST PERFECT EXISTING UNIT OF ANCIENT MAYA ARCHITECTURE (SEE PAGE 593)

All the chambers within this second story of the edifice have within the wall spaces opposite the entrances various niches about the height of the entrances, but narrower. None, even the smaller chambers, have less than two, and the long, narrow middle chamber on the south face has five.

These may have been doorways, originally giving entrance into the primitive structure, closed when the central portion was made into a solid core; but various circumstances, among them being the presence and position of the recesses in the walls of the end chamber, cause me to throw aside this hypothesis. To me they have all the appearances of having been true niches.

THE RECORDS OF THIS ANCIENT PEOPLE WERE DESTROYED BY THE SPANIARDS

They give, in the mind of the student of these old structures, the appearance of having been repositories. Perhaps within these niches were stored the rolls of parchment, the folded books on deerskin and agave paper, the plans and records, and all the written lore of this city of the Maya wise men, the "Itzaes."

Who knows but their contents formed part of that funereal pyre of ancient Maya literature made by the zealot, Bishop de Landa, on the Mani common.

De Landa, seeing on these old rolls of deerskin and volumes of maguey paper signs that he could not read and symbols that he could not understand, concluded that they were cabalistic signs of a diabolical nature, and caused them, together with many other objects of inestimable value to science, to be destroyed by fire on the public square in the Pueblo de Mani.

At that time the old chroniclers tell us there were destroyed 5,000 idols of distinct forms and sizes, 13 altar stones, 22 stones, carved and of small sizes; 27 rolls of ancient hieroglyphics on deerskin, 197 vases of all sizes and patterns, and many other unrecorded objects.

An ancient Spanish chronicler states naïvely that the natives who witnessed the destruction by fire were much afflicted and made a great outcry of woe.

Is it to be wondered that they made a great outcry of woe? They saw not only the sacred things calcining in the fervent heat, but also the written lore, accumulated knowledge of their race, going up in smoke and red cinders. Naturally the thinking ones among them "made great outcry."

Around the corners and on the unbroken portions of the smooth, hard finish in the recesses are traces of broad red, blue, and green bands forming the paneled outlines for the detail figures within. On the ceiling in places are still the fragmentary outlines of houses, trees, city walls, and nondescript animals.

On the inner walls of the eastern end chamber can be clearly seen the impress of the "red hand," another of the unsolved problems.

The third upper story is small and presents the idea of incompleteness, although its state of ruin prevents the last word being said until excavation and investigation have taken place under some competent person.

The last and least important of the seven structures yet standing is the so-called "House of the Dark Writings." The structure is a huge one-story edifice. Large forest trees grow over its flat roof, and were it not for its vertical wall faces of well-carved stone one could easily believe that he was treading the primeval forest floor.

The name, *Akab tzib,* House of the Dark Writing, was given to it by the natives because in the gloom of an inner chamber can be seen a lintel of stone, covered with glyphs and having on its under surface a seated figure in the act, apparently, of offering up some kind of burnt sacrifice.

This ends the list of the still existing structures; but the wonders to be seen prostrate and those hidden have not yet been mentioned.

We have not mentioned the sepulchers of the high priests, 90 feet beneath the crown of the pyramid, 50 feet in the solid rock; the rock carvings; jaguars carved on the ledge surface; the great natural well from whence this ancient city received its water supply; the caves, with their prehistoric defenses, stalactites, grottoes, and pools of clear, cool

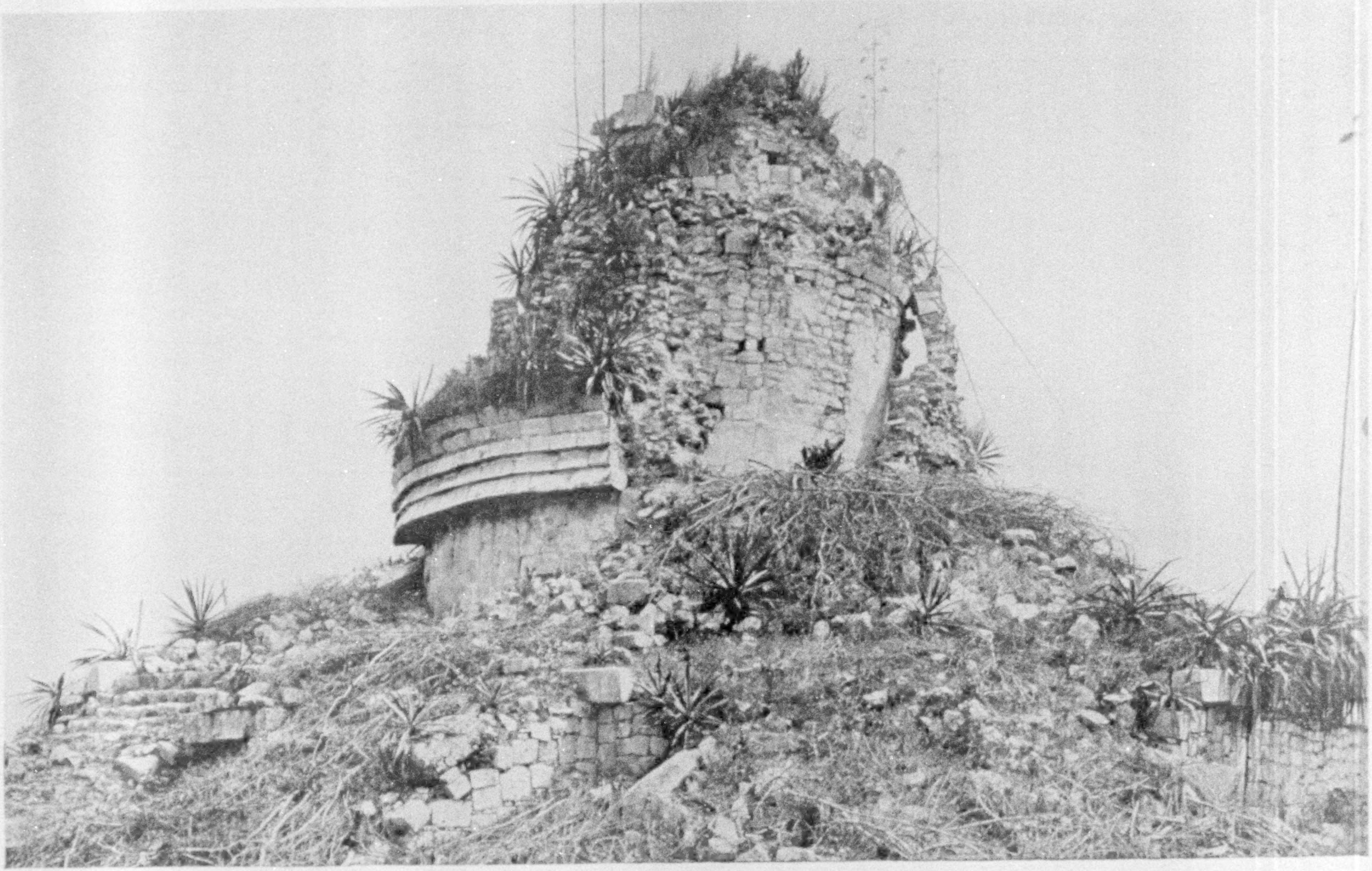


Photo by Edward H. Thompson

THE ROUND TOWER WHICH WAS PROBABLY THE ASTRONOMICAL OBSERVATORY

"From its construction, annular chambers, winding stairway, and the position of its outlooks and outlets, I believe it to have been an observatory, an edifice devoted to the study of the celestial bodies. It is known that the ancient American calendar system was so accurately developed that Alexander Von Humboldt was for a time incredulous of its native origin" (see text, pages 593 and 597).

water—these and many other things we have the desire to depict and describe, but time and space forbid.

WHEN WAS THIS CITY FOUNDED?

How old is this great city of stone-built temples and myriad carvings? For years we have sought among its fallen columns and toppled walls for that which would tell us clearly of its age.

To a certain extent the search has not been in vain. We have found a tablet of stone covered with hieroglyphs, and among them are signs that fix a date, an epoch. Keen minds and trained are now at work on the tablet, and the time may not be far distant when we shall know whether it be 2,000 years old or less, as some students claim, or over 11,500 years, as claimed by Le Plongeon.

The margin between the two "guesses" is certainly wide enough.

Meanwhile, like the Sphynx in the East, the gray, old human faces carved high on the massive walls gaze down unchangingly, unmindful of modern man and his futile guesses.

We have perhaps more information on the early history of this ancient group than we have of any other center of the Maya civilization.

But as that keen scholar, the lamented Dr. Thompson, was fond of impressing upon his pupils, "Gentlemen, information may or may not be facts, and unless it be of proven facts is not knowledge." Even "information" concerning these ancient builders and their buildings is only too scanty, and actual proven facts still more so.

THE LEGEND OF CHICHEN ITZA

The earliest information concerning Chichen Itza is given in a curious document found by Don Juan Pio Perez, a Yucatan scholar and antiquarian, among the dusty old records and archives in the Town Hall of Mani.

The document commences thus: "Lai u tzolan katun lukci ti cab ti yotoch Nonoual"—I might continue on in this way for some time, but all might not understand the text as clearly as could be wished. In fact, the fear of a sudden rupture of relations between writer and reader induces me to forego, and in place give a broad interpretation of the ancient writings in those parts where allusion is made to Chichen Itza.

Translated, the document commences thus, the brackets being my interpolations:

"This is the series of epochs that elapsed from the time of their departure from the house of Nonoual in the land of Tulapan.

"Then took place the discovery of Bacalar. Sixty years they ruled in Bacalar, when they came here.

"During these years of their government of this province of Baçalar occurred the discovery of Chichen Itza. 120 years they ruled in Chichen Itza, when they left it and went to Champutun, where the Itzaes, holy men, had houses.

"260 years reigned the Itzaes in Champutun, when they abandoned it and returned in search of their homes.

"For several epochs they lived in the woods and the caves, under the uninhabited hills.

"After forty years they returned to their homes (Chichen Itza) once more, and Champutun knew them no more.

"Two hundred years they reigned in Uxmal, Chichen Itza, Mayapan. The governor of Chichen Itza (Chac xib chac) was deposed because he murmured disrespectfully against Tunac-eel, the governor of Mayapan. Ninety years had elapsed, but the tenth of the 8th Ahau was the year in which he was overthrown."

The unknown native writer keeps on; but I will stop, as he mentions Chichen Itza no more.

Neither the name nor the history of its writer is known; but from the perfect command of both the native vernacular and the Spanish letters it would seem to have been the work of an educated native and written within a few decades after the conquest. This would not be strange, for many bright young natives, sons of the nobles and of the reigning families, were taken by the church or by high lay officials and educated in Spanish learning.

Thus Caspar Antonio Xiu, the lineal

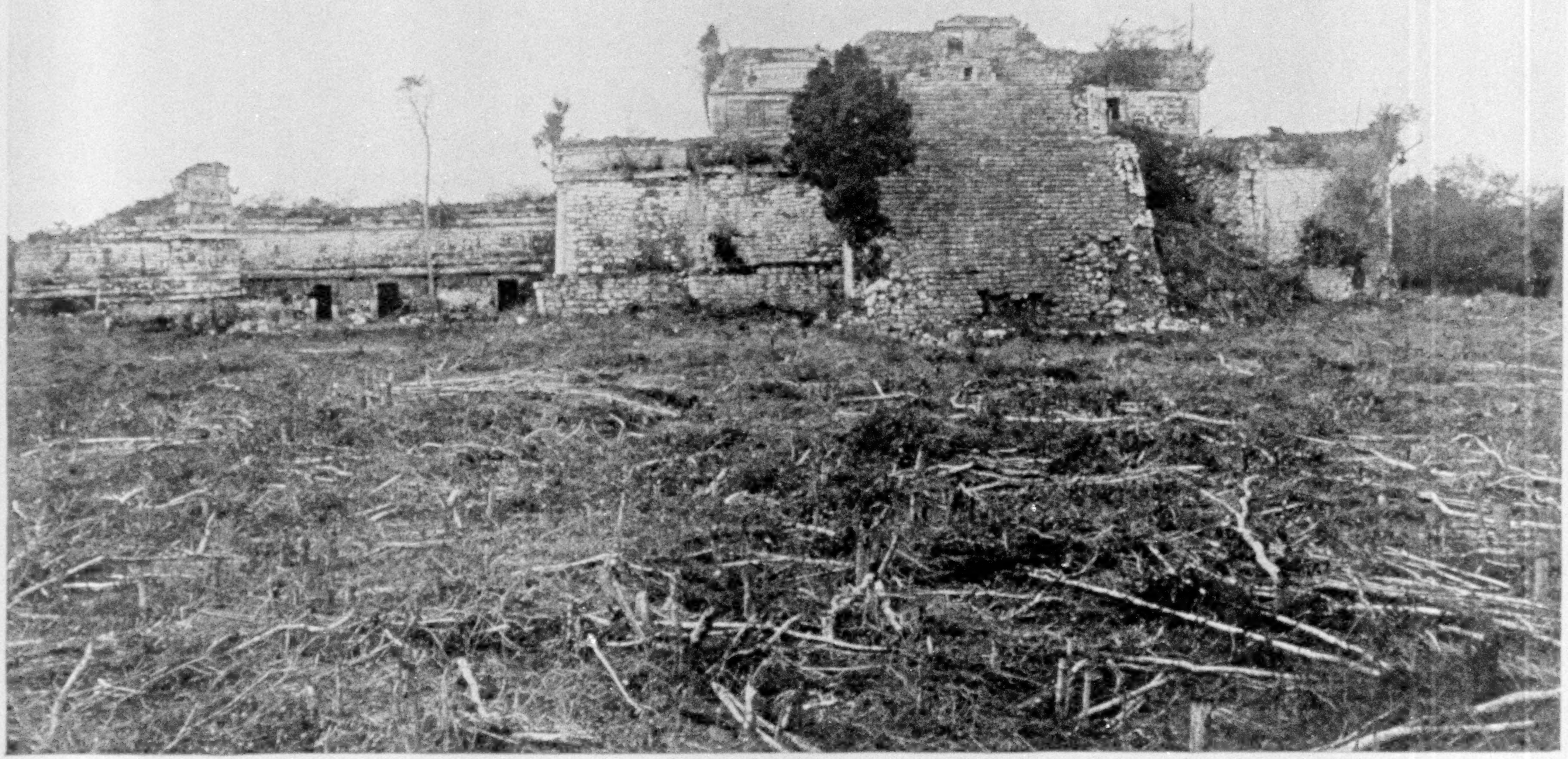


Photo by Edward H. Thompson

THE MAJESTIC PILE OF THE NUNNERY

"The true beauty of the carvings and the perfect proportions of the structure can never be fitly shown until the debris that now hides the base and destroys the true symmetry of the edifice is removed. . . . The stone lintels over every entrance, existing or blind, built into this face of the end walls are covered with handsome, still legible, glyphs. Clearly legible indeed, but as unreadable as a sealed book. Undeciphered and mysterious, they are the pleasure and despair of those who seek to solve the problems that they hold" (see text, page 597).

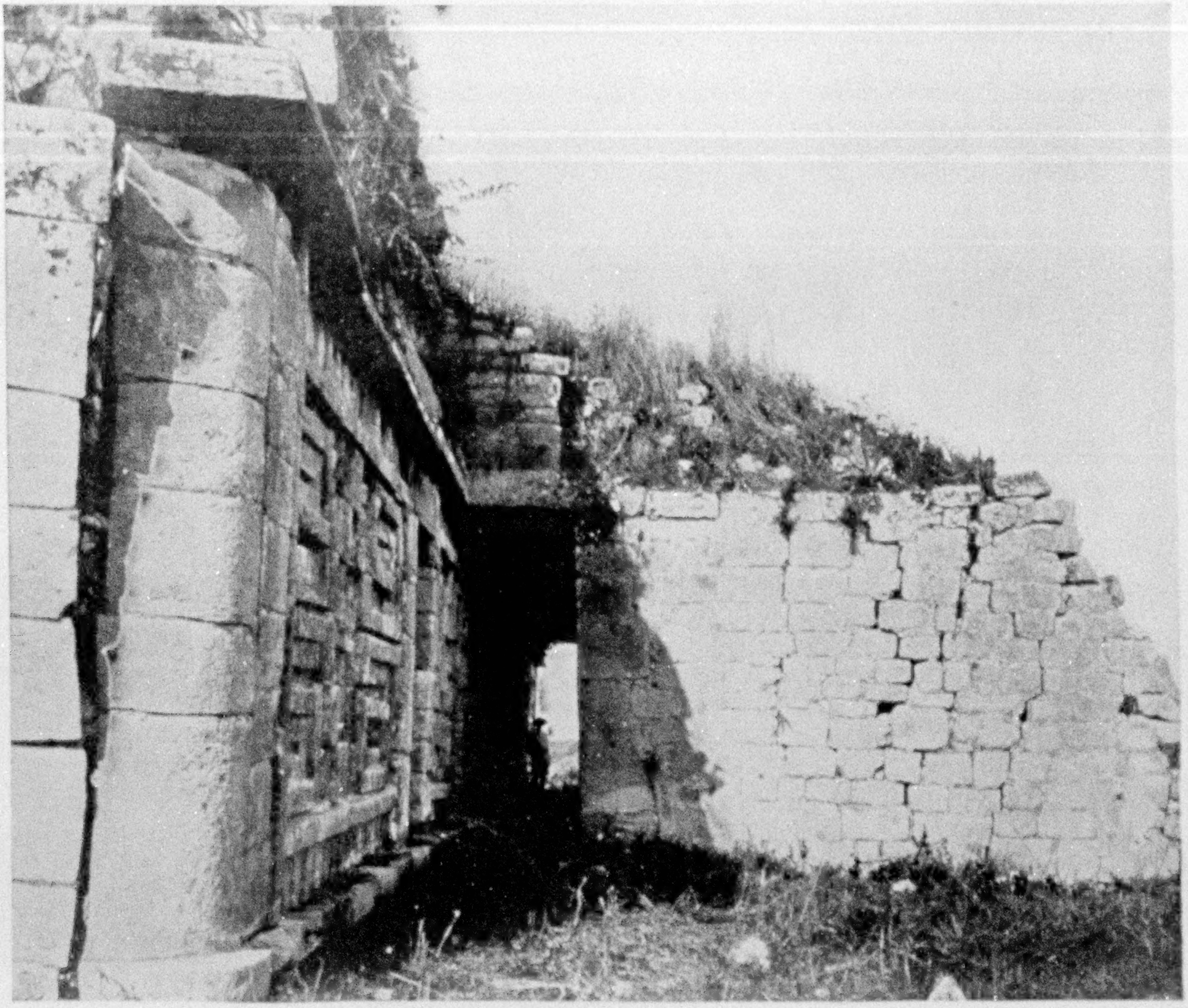


Photo by Edward H. Thompson

OVER THESE A FLYING BUTTRESS WAS THROWN AS STAIRWAY TO THE NEWER STRUCTURE ABOVE (SEE PAGE 597)

descendant of the last king of Mayapan, was taken, baptized, and educated by Montejo, the conqueror of Yucatan and its first governor.

THE ANCIENT MAYAS HAD THEIR BARDS AND STORY-TELLERS

The ancient Mayas, like most other races, had their bards and story-tellers, who interwove into their songs and tales the history of their people.

Thus, I repeat, it is not strange if some educated native filled, like the gifted Tescucan Ixtlilxochitl, prince and writer, with the desire to perpetuate the fading history of his people, had recourse to the device of writing out, as his memory served, their early wanderings and ancient history, and then, with native subtlety, to hide the documents under those longest filed away and in archives likely to be safe and undisturbed until times far later.

There is a legend of Chichen Itza that has seemingly more of the material of true history in its making than legends are usually thought to have. At all events, it is genuinely romantic and worth repeating.

THE LEGEND OF CANEK

Canek, the impetuous young ruler of Chichen Itza, was deeply in love with a beautiful maiden, daughter of the ruler of a distant province. No longer were his thoughts on the coming hunt of the jaguar; the wild boar passed grunting and unharmed, even unnoticed, as the young ruler sat musing on a fallen log. A fawn, chased by the hunters, became entangled in a snare close beside him as he sat motionless, happily musing. Seeing that its big, soft eyes were like those of the maiden he loved, he loosed its bonds and set it free.

In the midst of his amorous musings, as he sat in his chamber one day, a dust-covered runner came up to the palace entrance and rattled the sounding shells before the curtains for instant entrance on the ruler's service.

The news he brought drove the young ruler to desperation.

The Batab of a neighboring province, and one far more powerful than he of Chichen Itza, had married the maiden that Canek was to take to wife.

For a while no raging jaguar robbed of his mate was more furious than young Canek; then of a sudden he grew quiet, cool, and seemingly calm.

So his warriors remembered to have seen him when they fought an old-time enemy, killed his fighting men, and defaced his temple, and they patiently waited.

The night came and with it a brooding norther. Darkness as black as the hate in the heart of Canek was all around the silent ranks of the swiftly moving warriors. The lightning flashes, as sharp and hot as the anger that flamed in the Canek's breast, played over the glinting points of crystal on the moving forest of lances as they neared the enemy's city.

The ever-burning flames on the top of the distant temple gleamed redly, and black smoke went heavenward in increasing volume as the priests burnt great baskets of copal in honor of their ruler's marriage.

Canek and his silent warriors came swiftly onward, melting into the darkness of the shadows, hiding from the lightning flash, leaping ahead like deer when chance offered. Revelry had taken the city with all that was in it and held it hard and fast. Even the watchers were drunkenly grumbling over the fate that kept them out of the carousals and in the darkness. As the black and moving shadows reached them swiftly they soon were quiet and out of the darkness for evermore.

THE INTERRUPTED MARRIAGE

And the deer-eyed woman—a wife, yet still a maiden—was she happy? Oh, who knows! It may be that her eyes were not pain shadowed; that it was but the dim light of the wild wax tapers in the narrow vaulted chamber, and it may be that which glistened on her drooping lashes was but the flashing of stray light beams from between the entrance curtains. Who knows?

Merry were the wedding guests and well drunken most of them. More than merry was the bridegroom, who drank the deepest of them all. His brain was sodden, his limbs rebellious, but his tongue, though thick and clumsy, still responded to his call.

Sodden brain and clumsy tongue worked together as he mumbled loudly:

"As for the Lord of Chichen Itza—poor lean dog—let him take his pleasure howling at the moon tonight! Before I seek my wife's caresses in her many-curtained chamber, I must hear a lively song. Ehen! Holcanes! Tupiles! lift your voices and rattle out the battle song."

Drunkenly mumbling, stupidly fumbling, he rolled on his side and fell asleep.

At the holcanes' call the tupiles started the great war song of the Mayas—"Conex, Conex Paleche" ("Come on, come on, ye warriors").

The voices that commenced it were well known, though drunken and quavering; the voices that joined in it and ended it were strong, full, and shrilly menacing. Abruptly the drunken voices ceased and some ended with a groan.

The deer-eyed woman, alone in her curtained chamber, heard the voices and the singing, and then the strangeness of the tumult drove her to the carved stone entrance. Before she reached it the shells were rattled and the curtains parted swiftly. "Star of the night! Star of my life!" said Canek.

"My Lord Canek," said the maiden, with startled eyes, but star lit.

Dead men, live men, and the live men dead in drunken stupor, what could the few with senses unbenumbed do against

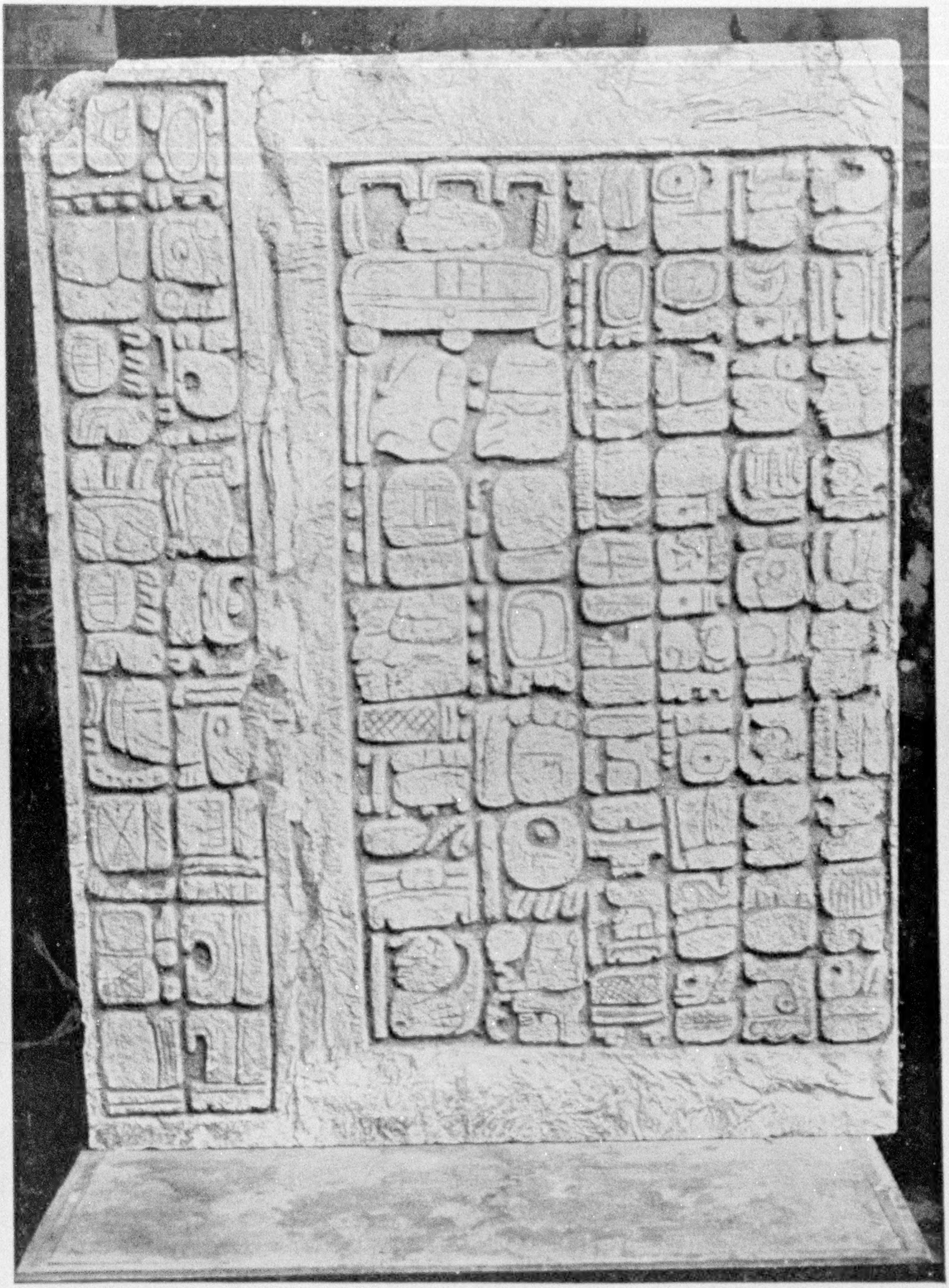


Photo by Edward H. Thompson

A PAGE OF STONE THAT NO MAN MAY YET READ

"How old is this great city of stone-built temples and myriad carvings? For years we have sought among its fallen columns and toppled walls for that which would tell us clearly of its age. To a certain extent the search has not been in vain. We have found a tablet of stone covered with hieroglyphs, and among them are signs that fix a date, an epoch. Keen minds and trained are now at work on the tablet, and the time may not be far distant when we shall know whether it be 2,000 years old or less, as some students claim, or over 11,500 years, as claimed by Le Plongeon" (see text, page 601).

XUM

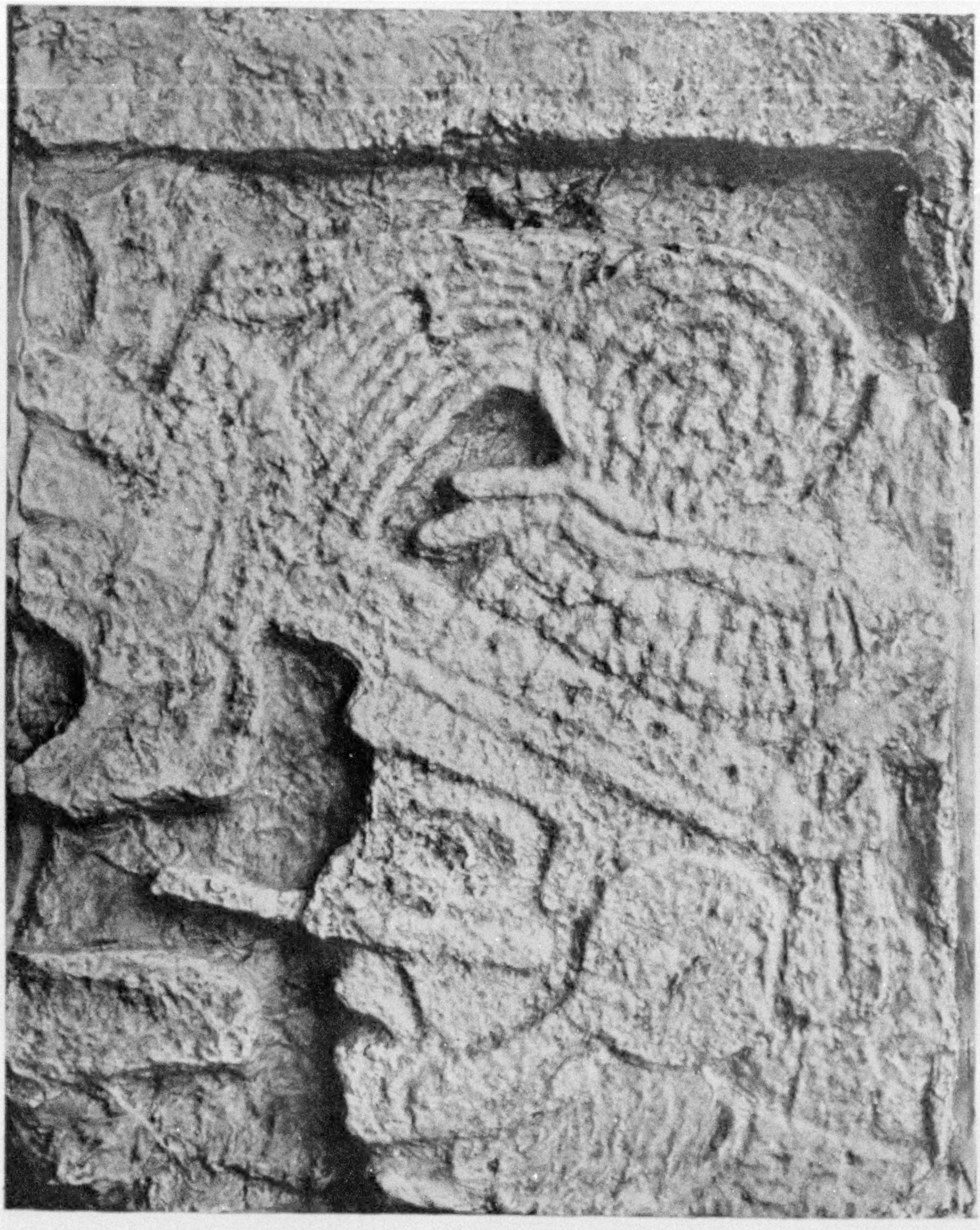


Photo by Edward H. Thompson

PHOTOGRAPH OF A HUMAN HEAD CARVED IN STONE: PORTION OF A RICHLY CARVED WALL SURFACE RECENTLY DISCOVERED AT CHICHEN ITZA

All the rolls of parchment and books on deerskin and agave paper, all the plans and records and the written lore of the mysterious city, Chichen Itza, were burned by the Spanish zealot, Bishop de Landa. When he saw the Maya symbols that he could not understand, he concluded that they were signs of a diabolical nature and caused them, together with many other objects containing Maya records, to be destroyed by fire on the public square of the city (see page 599).

the silent fury of Canek and his fighting men?

Never again did Chichen Itza know its Lord Canek, nor any of his band of fighting men. In the passing of a night they vanished, the Lord Canek and the soft-eyed maiden, the stolen bride of the drunken one.

Time passed. The lord who won a bride, but did not learn to keep her, lived his life, died, and was forgotten.

The memory of Lord Canek lived on in song and story and became a part of the legends of Chichen Itza.

THE LOST IS FOUND

One day, long after, a hunting band from Chichen Itza went toward the south—some days' journey. Young men they were and full of rashness, so they kept on the chase until the lane grew hilly and higher, and at last rose into the very clouds. Wonderingly, they turned homeward, journeying over a strange country, until they reached a lake of shining water, and in the lake an island city, with houses and temples and the carved fronts of many buildings like their own Chichen Itza.

From this island city warriors came and met them and led them to the waiting ruler and his aged wise men.

"Who are you, presumptuous ones, that you dare to come unbidden on our land and unwanted to our city?" asked the Batab in stern menace.

The young man spoke bravely, coolly: "We came from our home, Chichen Itza, and have wandered here unbidden because in the chasing of the deer we went farther than we knew; and, finding pathways right before us, we kept on, thinking to find old friends or make new ones."

The ruler turned and took counsel with his wise men, then said to the waiting hunters: "If your tale be true, that you are of Chichen Itza *and not of another province*, you will indeed find here old friends new made—old friends and new as well.

"This is the city of Tayasal, whose lord is Canek, who once was lord of your own Chichen Itza, the City of the Sacred Well."

This is the legend. The substance is as told by the good old, but very dry, chronicler, Padre Cogolucco. I confess to have taken this skeleton and put a little flesh on here and there, just to round out the form—a little brown and red, just to give a local coloring, and so produce the true general effect; that is all. But perhaps I had better have left it as the ancient priestly scribe tells it; "quien sabe"—who knows?

Not all of the tales of Chichen Itza are prehistoric or legendary.

Far later, chronologically, than the legend of Canek, a proven fact, with only a small portion of "information" embedded in it, is furnished us, and brings us down to the historic times of the early Spanish conquerors, when they were in deadly struggle with the fearless Mayas.

MONTEJO WELCOMED

In 1525-1526 Montejo was weary with his long and seemingly fruitless struggles against the native Mayas. Constantly buffeted by his countless enemies and having no place of refuge, he found himself in imminent danger.

The overlords of the provinces near the coast, known by the name of *Cheles* (bluebirds), were in a way friendly to the Spaniards, and Montejo found his way toward them. The other Indians, seeing that the Spaniards were headed coastward and thinking that they were seeking to return from whence they came, did not seek to fight or in any way annoy them; thus the Spaniards arrived safely at the home of the *Batabs Cheles*.

These received them hospitably and, in response to the petition of Montejo, allowed them to find a safe asylum at Chichen Itza, then governed by a vassal chief, Cupul.

Upon their arrival, Cupul, according to a native document, "The Narrative of Nahum Peck," said to them:

"Stranger lords, take your rest in these halls," and they did; they made themselves very much at home, after the manner of the Spanish conquerors of those days, even before they had fairly earned the proud title.

For a time the Indians bore the burdens that their guests put upon them with meekness, but at last they rebelled at having to be the providers and burden-bearers for such lusty feeders and poor paymasters, and then their actions soon put the Spaniards in a serious plight.

Finally, besieged and almost without provisions, they took advantage of a stormy night after a brave sortie to deceive the Indians. One by one they deserted the edifice used as their garrison and stole away in the darkness, to unite and make for a more friendly haven.

DOG, ROPE, AND BELL

It is said that to deceive the Mayas into thinking that they were there they tied a dog to the rope of a bell and placed food in front, just beyond his reach. His frantic efforts to get at the food rang the bell at frequent intervals, while the constant bark aided the supposed deception of the Mayas, and when at last the ruse was discovered the little band of Spanish soldiery was nearly out of the enemy's reach.

Thus runs the chronicle, and the story may be true; but, knowing, as the writer does, the character and customs of the direct descendants of these same old Maya warriors, he does not believe it. It is far more probable that these Mayas, desiring to be quickly and peacefully rid of their burdensome guests, shut their eyes to the going of the Spaniards and would have been the more obliged to them if they had taken the bell and the dog along with them as well, and so left the besiegers to enjoy their early slumbers undisturbed. The discreetly dropped eyelid, that is almost a wink, and quickly changes into a blindness, is an artful act as ancient as the human race. In many respects the logic of the native Maya is peculiarly his own, but in many other ways his acts and artifices are as old as man himself.

ELOQUENT SILENCE

The writer has often been asked, "After one has visited the ruins of the Old World, is it worth while to visit those of the New World?"

He has had as visiting guests scientists of other lands, men with the wonders of Italy, of Egypt, and India fresh in their memory, inquisitive, incredulous, but desiring to see what there was to see.

As these great, lonely monuments loomed up before their vision, he has noted the quick, surprised intake of the breath, the change of color even, and then—a speaking silence far more eloquent than any words could be.

The American people should awaken to the fact that they have right at home, at their very doors, architecture essentially American, as it were, ruined structures every whit as interesting, as massive, and possibly as old as those of other lands, whose boast it is that the Americans must come to them, for "America has no ruins."

Within these mysterious ruins—American ruins—are great books, with pages of stone, writ in characters that no man may yet read. Are the mysteries they hold, the wonderful facts, that certainly lie sealed and mute within them, hidden from us, less interesting to Americans than are the tales of Egyptian dynasties, the rites of Druids, Roman campings, or Saxon raidings? I think not.

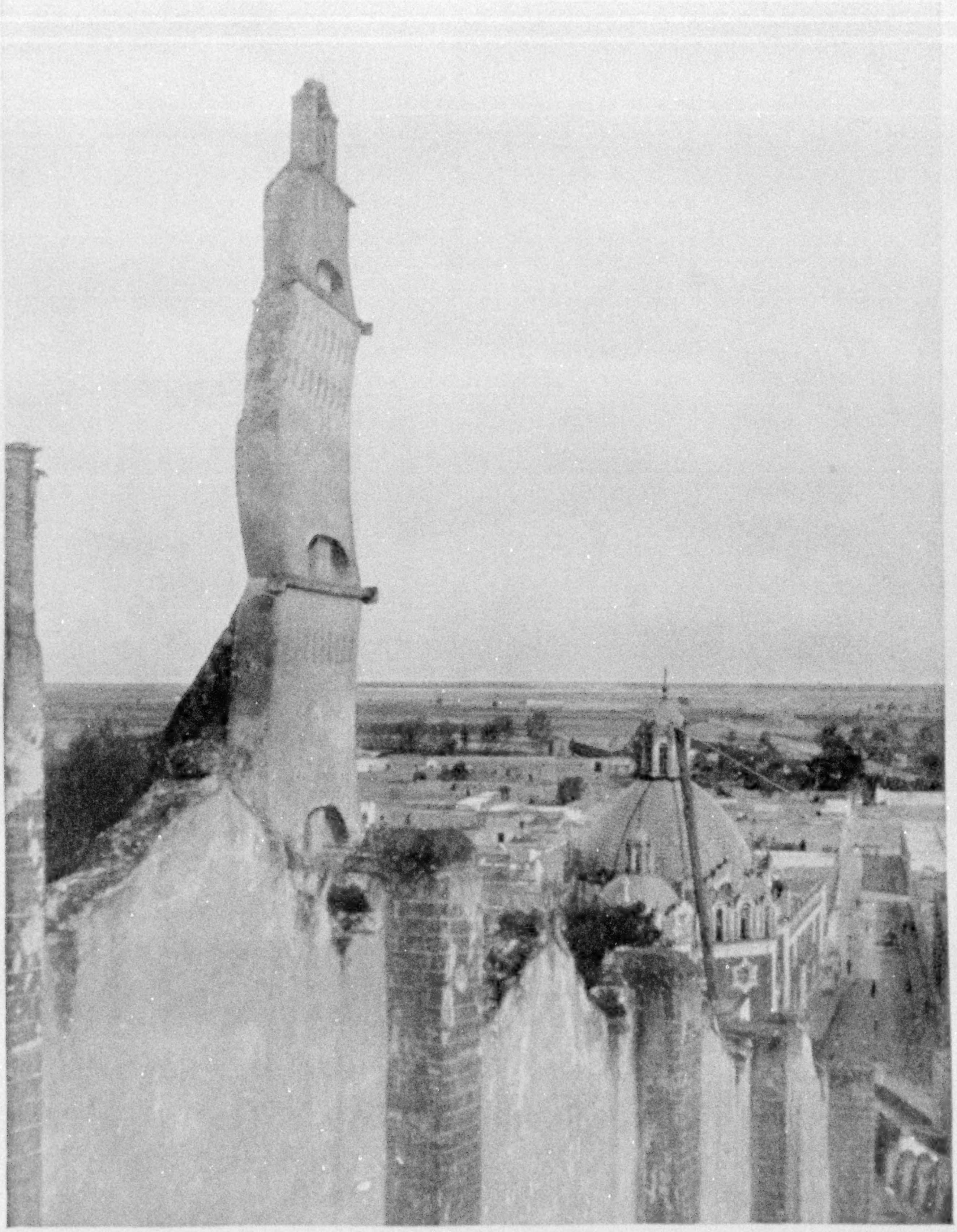


Photo by B. F. Langland

STONE SAILS AT GUADALUPE, MEXICO

Tradition has it that certain sailors who thought themselves lost in a storm vowed to the Virgin that if she would deliver them they would drag their mast to the top of the hill at Guadalupe and set it up as a memorial to her protecting power. They were delivered and fulfilled their vow, building sails of stone around the mast to protect it.

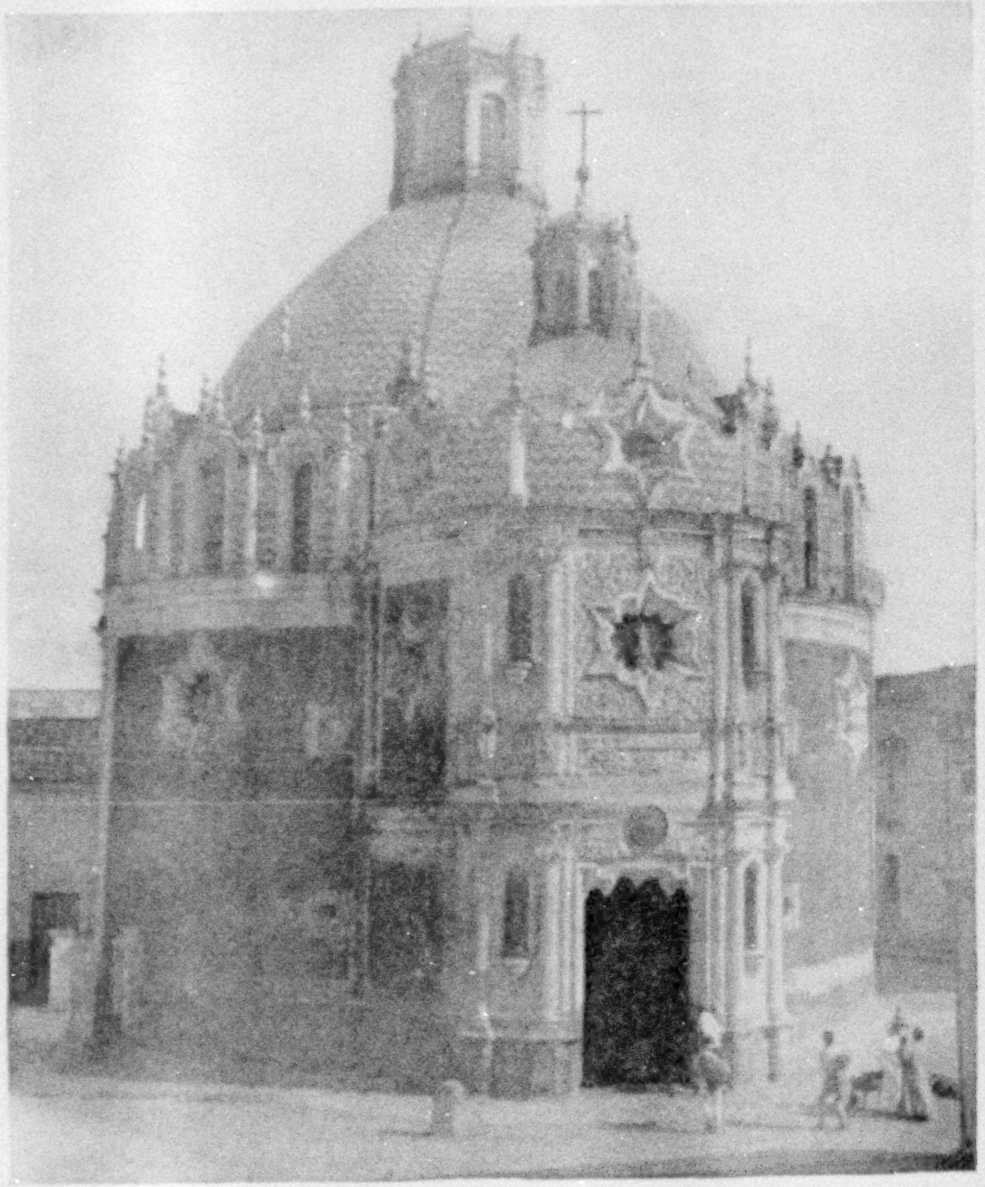


Photo by B. F. Langland

THE CHAPEL OF THE WELL AT GUADALUPE

When, according to tradition, the Virgin appeared before the Indian, Juan Diego, and ordered him to gather flowers on the desert Tepeyac Hill to carry to the Archbishop as evidence of the apparition, a bubbling spring burst forth beneath her feet. This chapel is over that well. It was built by the devout people, the women of the best families serving alongside the peons in the construction work. It is said that whoever drinks from this well must perforce return to Mexico.

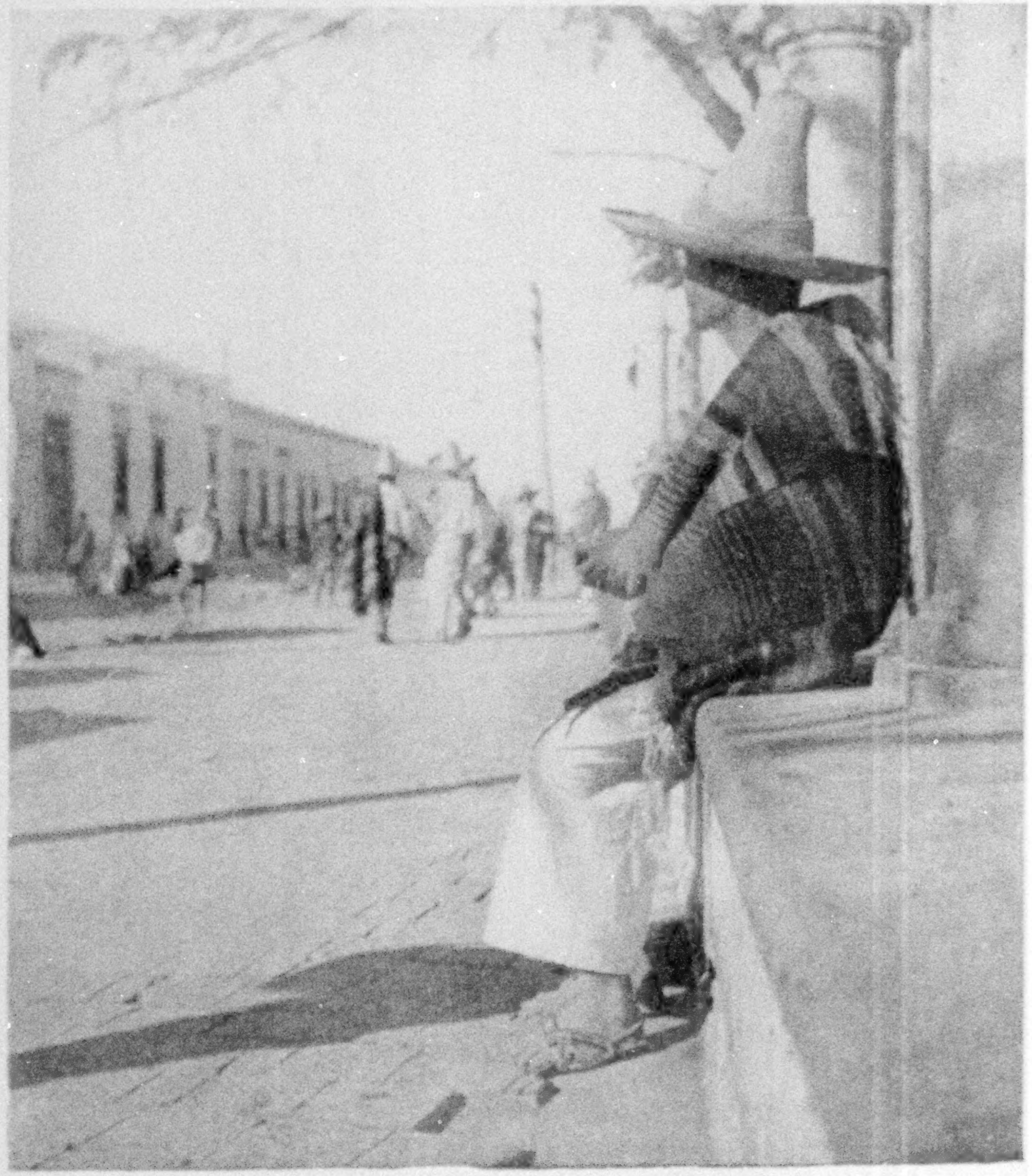
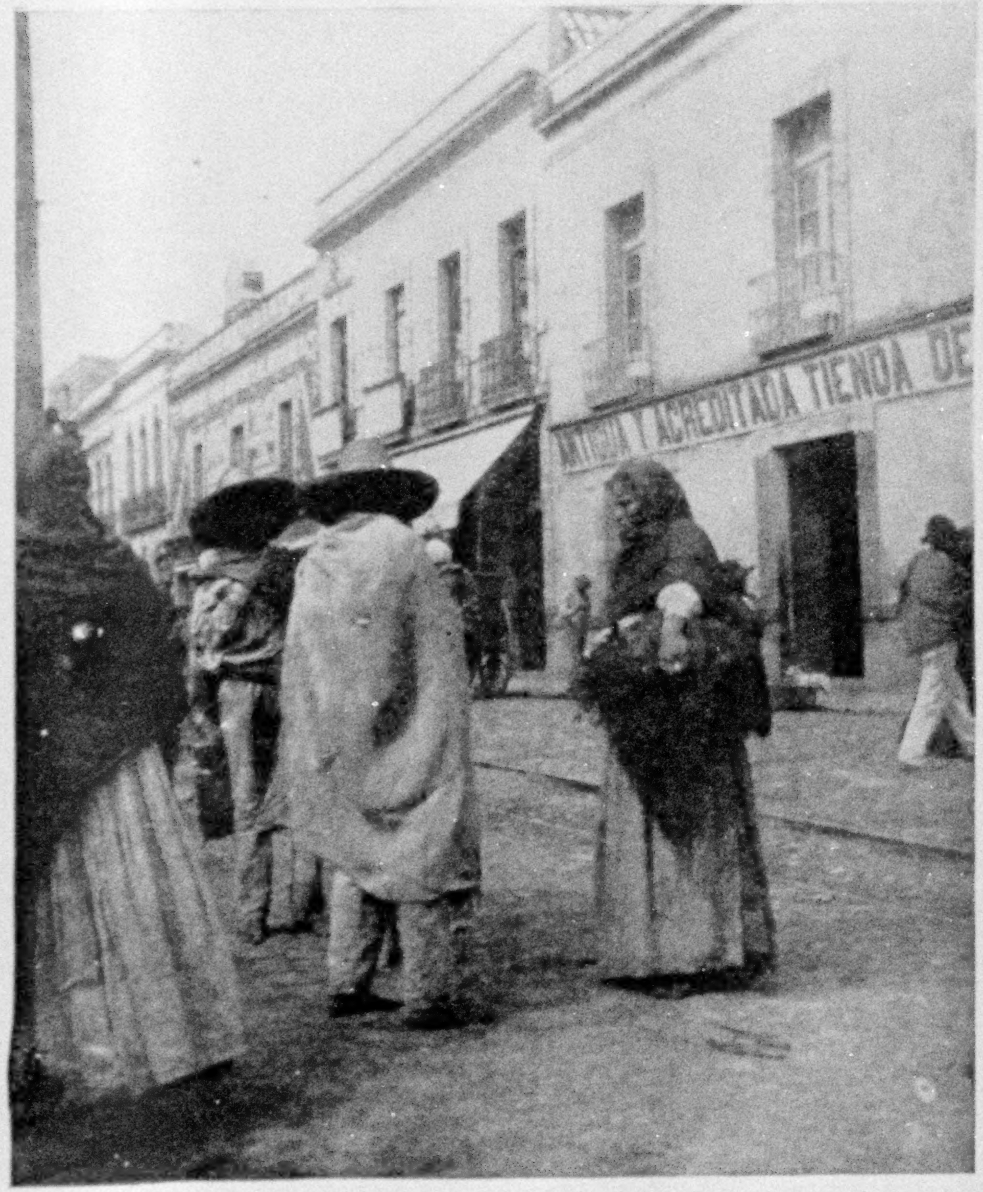


Photo by B. F. Langland

A MEXICAN BEGGAR

The beggar population of Mexico has always been a numerous one, in spite of rather sternly enforced laws against begging



ANTIGUA Y ACREDITADA TIENDA DE

Photo by J. Langland

THE SARAPE AND THE BLACK SHAWL

Wherever you go you meet the Indian man wearing his sarape and the Indian woman her black shawl. These serve as clothing by day and as bedding by night.

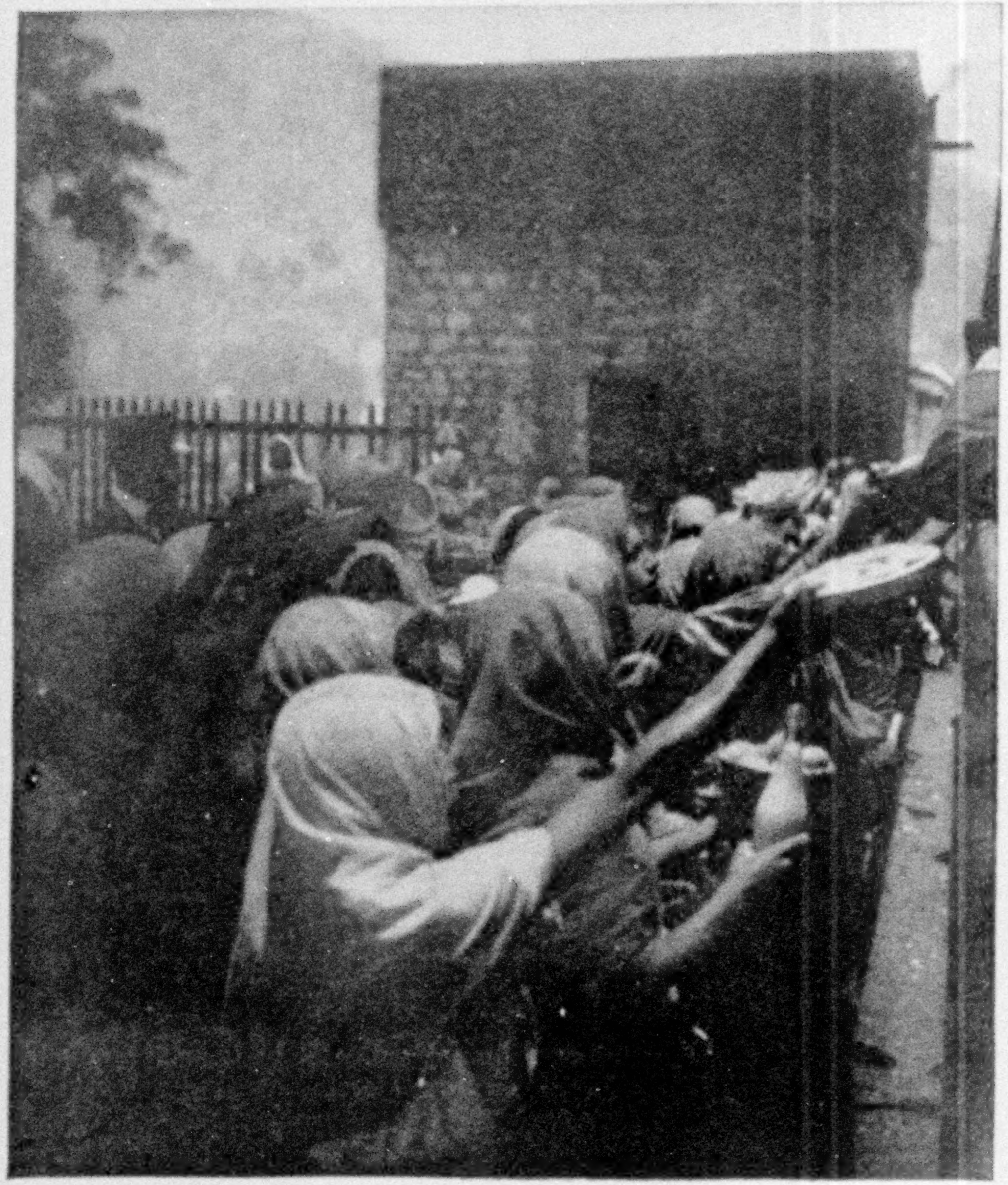


Photo by J. Langland

SELLING FOOD TO PASSENGERS ON A RAILROAD TRAIN: MEXICO

No traveler ever needed to go hungry in Mexico, provided he had a few centavos and an ability to forget the maxim of his childhood, that "cleanliness is next to godliness."

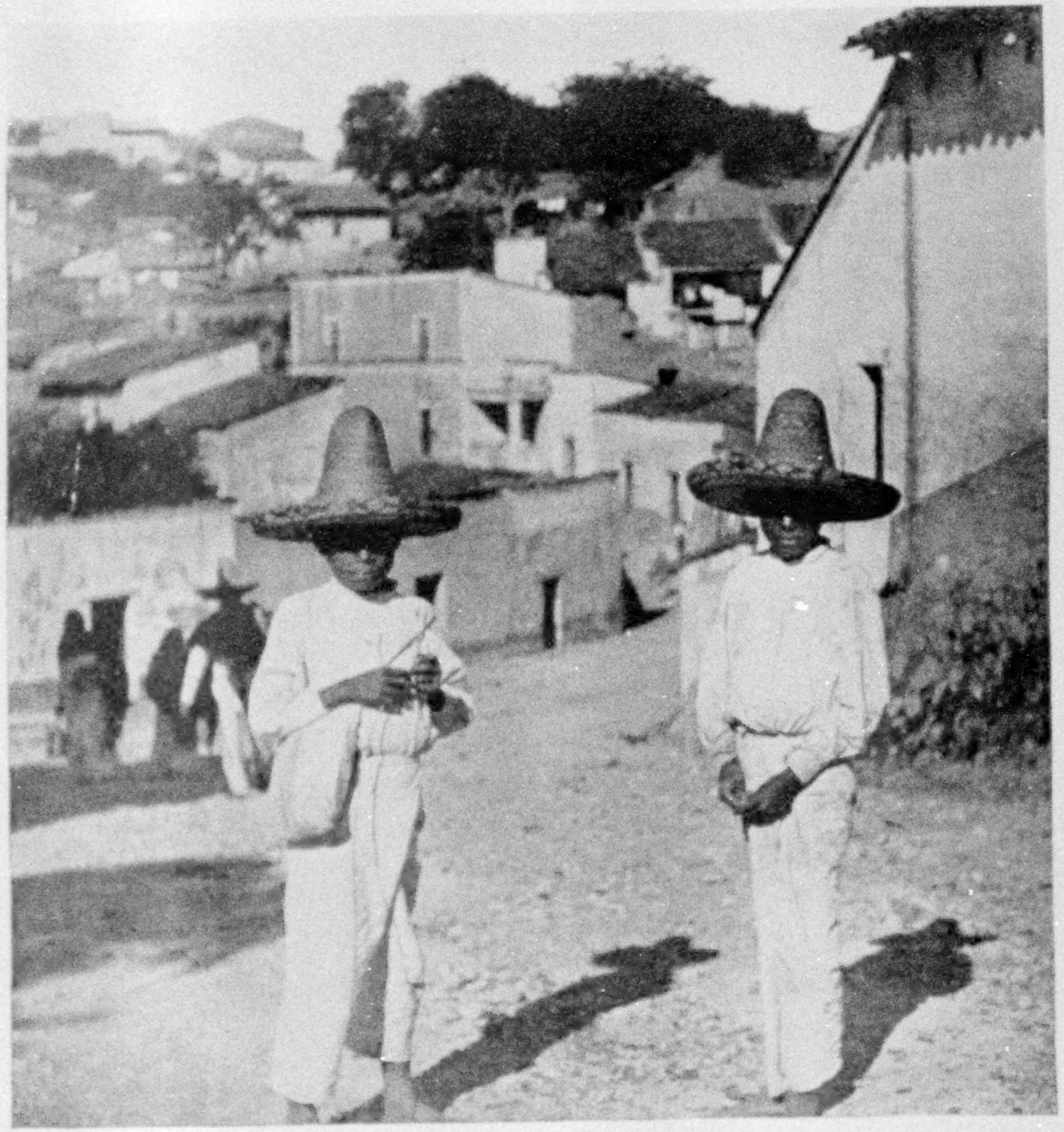


Photo by J. Langland

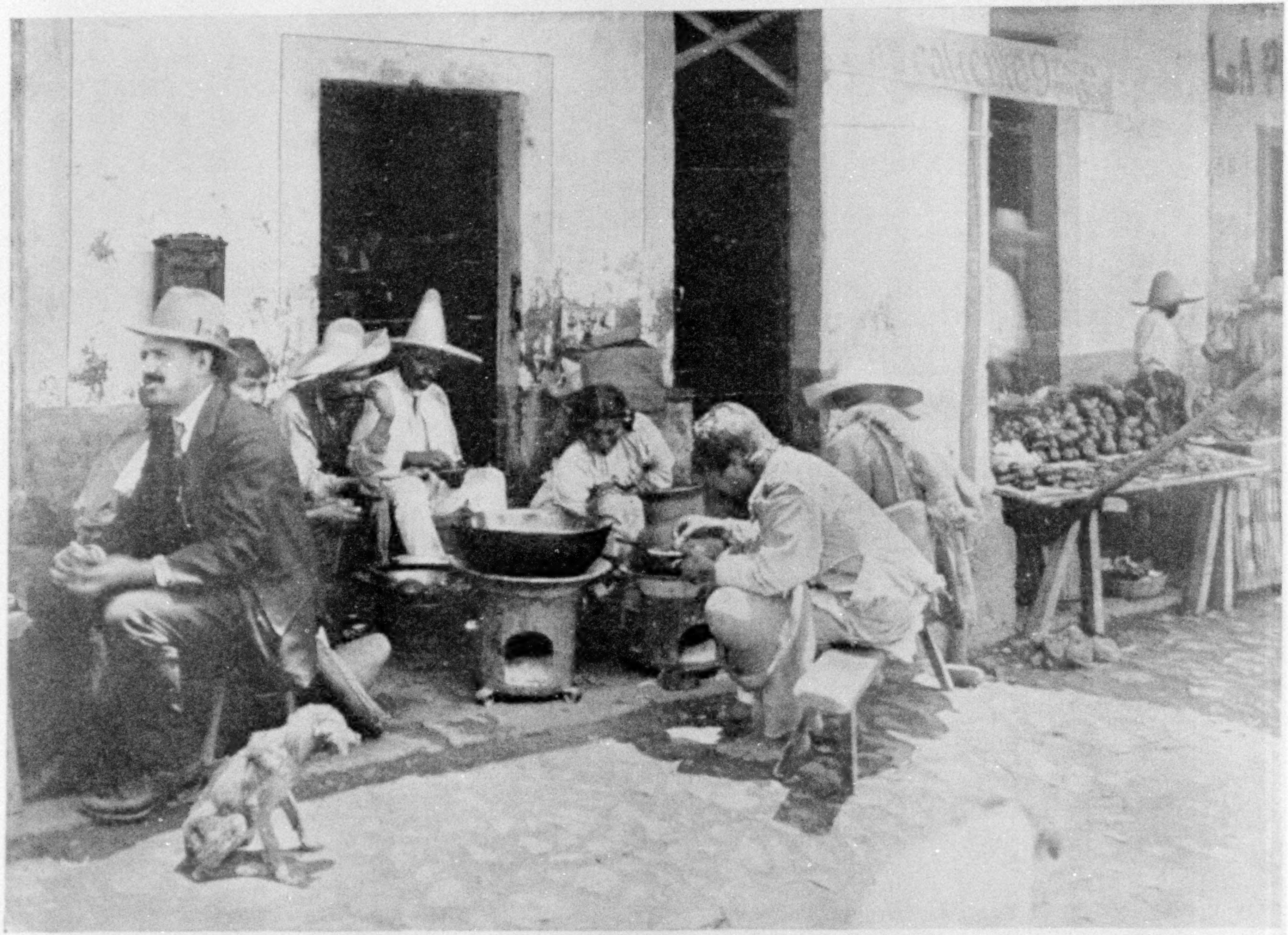
MEXICAN BOYS AT CUERNAVACA, MEXICO

The peon does not make much money and he does not need a great deal. His boys wear cotton trousers, cotton shirts, and straw hats; so his clothing bill is small.

Photo by J. Langland

BEGGAR WOMAN AT RAILROAD STATION: GUADALUPE

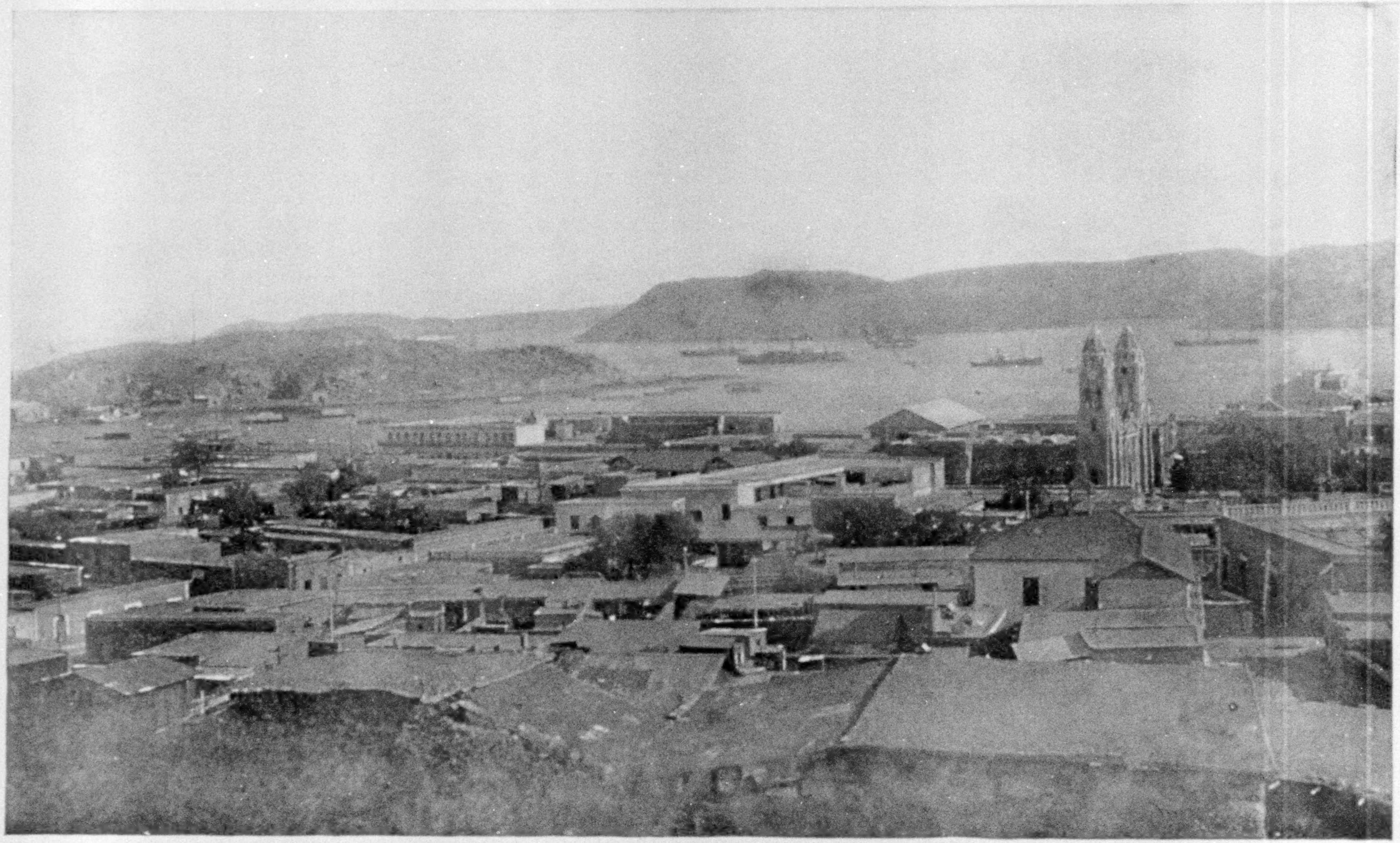
From the Guatemalan frontier to the Rio Grande, "Un centavo, señor," rings in your ears, and you reply "Pardonne me por Dios" so often that you feel like carrying a talking-machine with you to say it for you every minute of the day.



A WAYSIDE INN IN MEXICO

Photo from Alberto L. Godoy

At such places they know about as much about the germ theory of disease as a new-born babe knows about the fourth dimension, and they care less. Their systems seem to become as calloused to germs as their horny palms are to blisters



THE TOWN AND HARBOR OF GUAYMAS, MEXICO

Photo by Charles Jenkinson

The city of Guaymas is one of the principal seaports of the Gulf of California. Several railroads find their outlet here

XUM

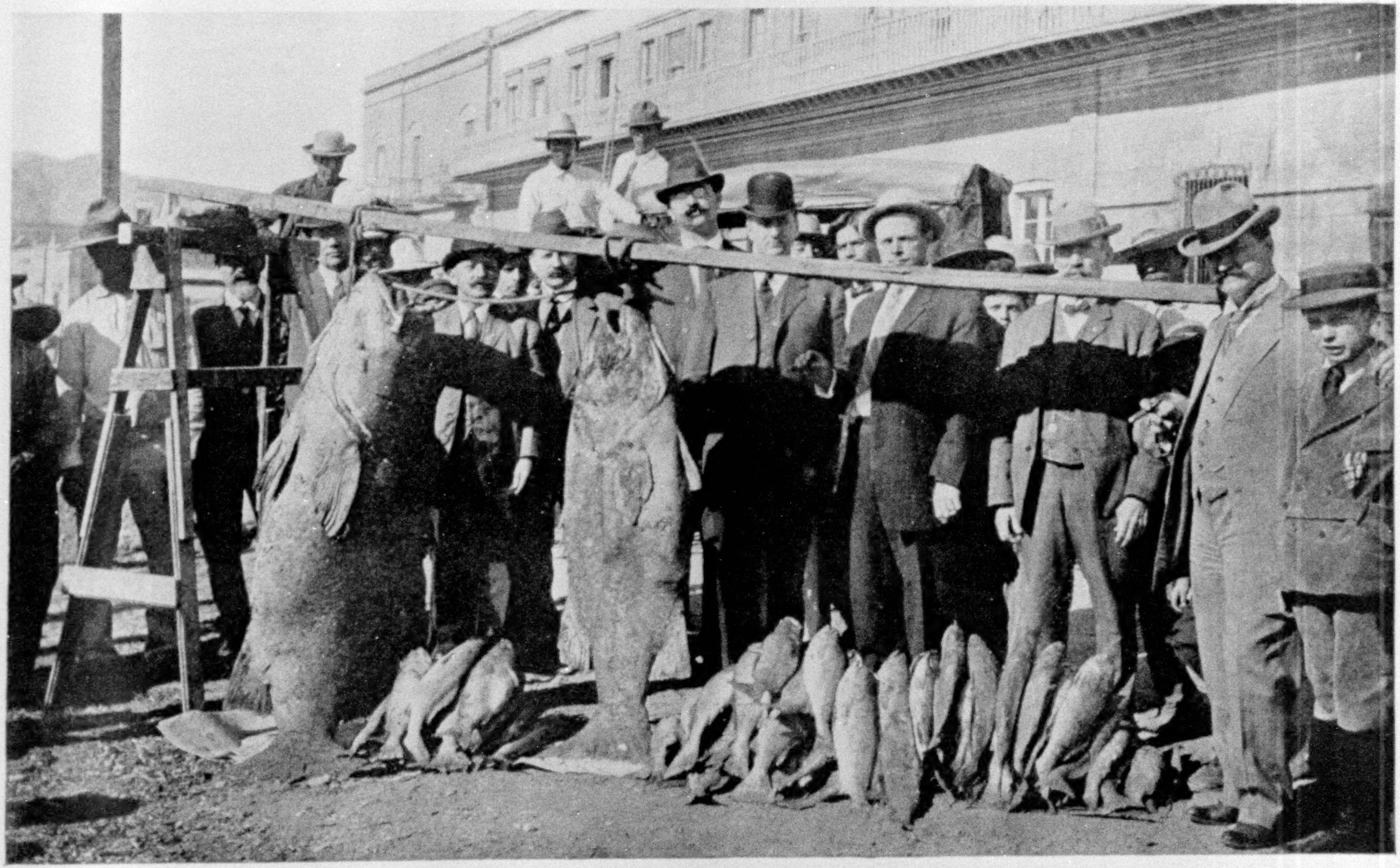


Photo from Charles F. Holder

GUAYMAS, SONORA: MEXICO

The outlying waters of Guaymas Bay are to the people of Mexico what the neighborhood of Catalina Island is to those of the United States. In years gone by fishermen from all points of the compass visited the fishing grounds of Guaymas. The Colorado River salmon, the jewfish, the Spanish mackerel, and the *boca dulce* are there in abundance.

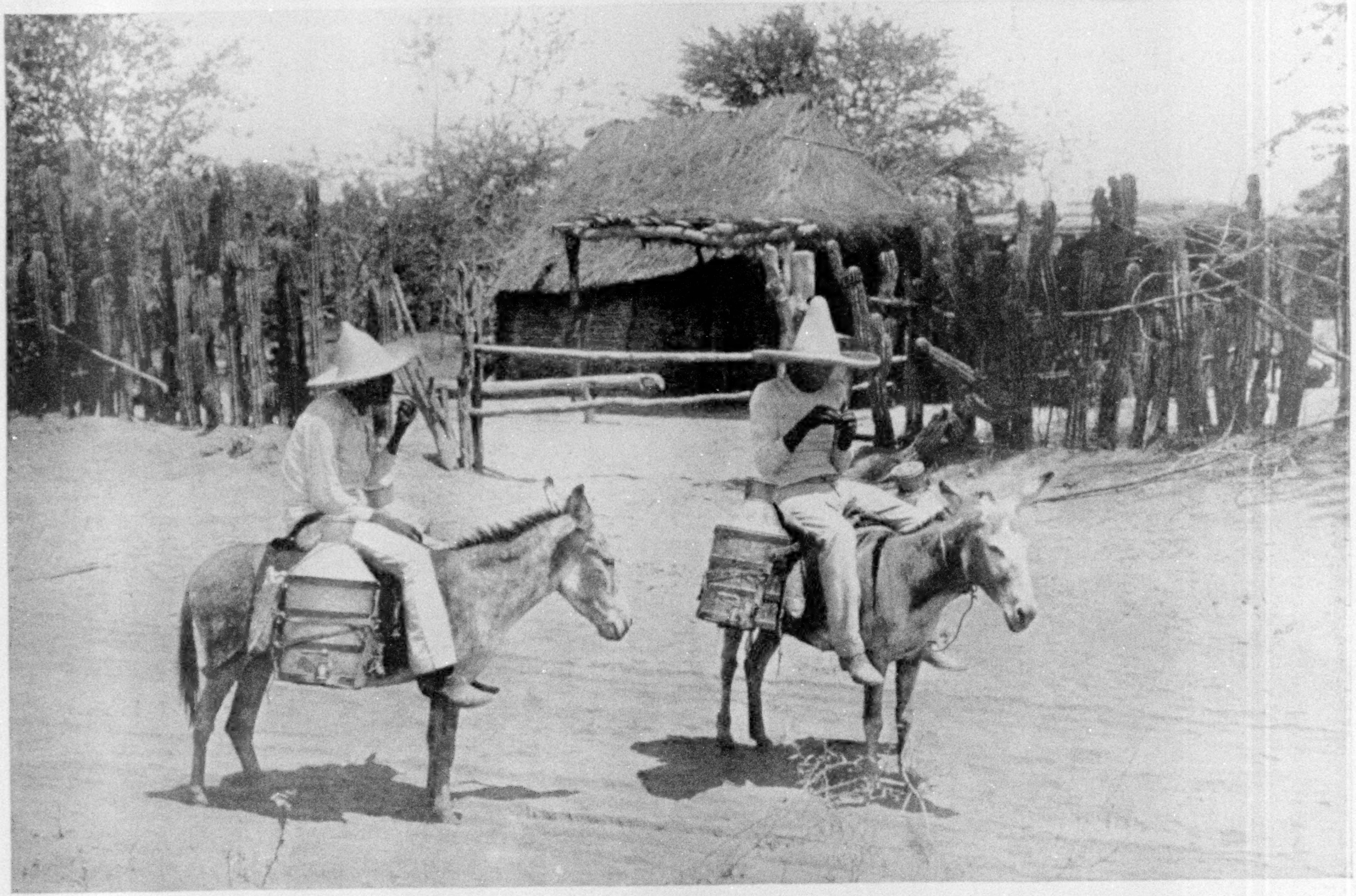


Photo from A. H. Blackiston

THE MEXICAN MILK-WAGON

Nearly everybody who uses milk in Mexico boils it; and when one sees the conditions under which it is produced and marketed, he is a convert to pasteurization

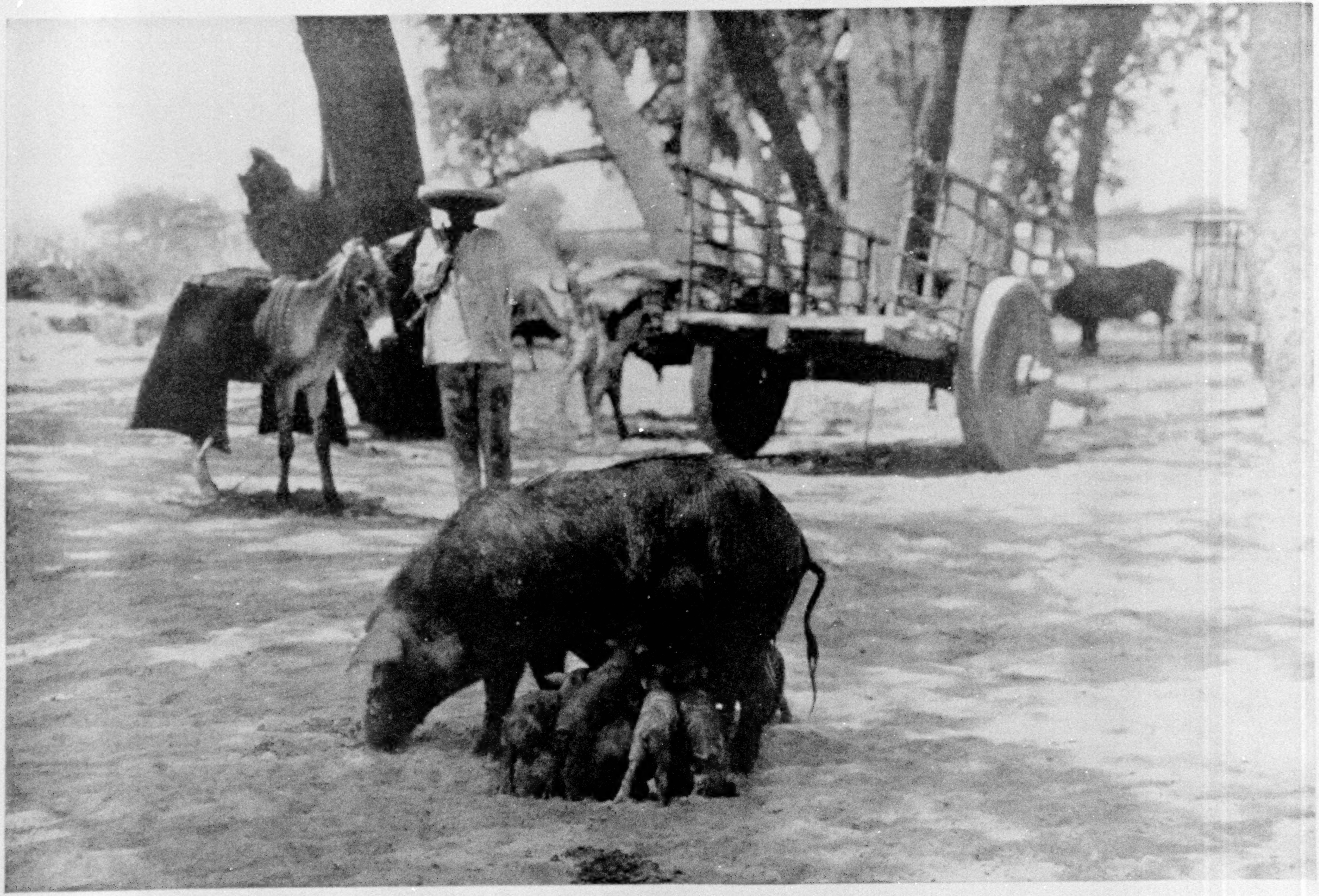


Photo from A. H. Blackiston

A COUNTRY SCENE: SINALOA

The solid-wheeled ox-cart, the razor-backed hog, and the indifferent donkey are as much a part of the rural scene in Mexico as the self-binder, the herd of fat cattle, and the team of fine horses are in the United States

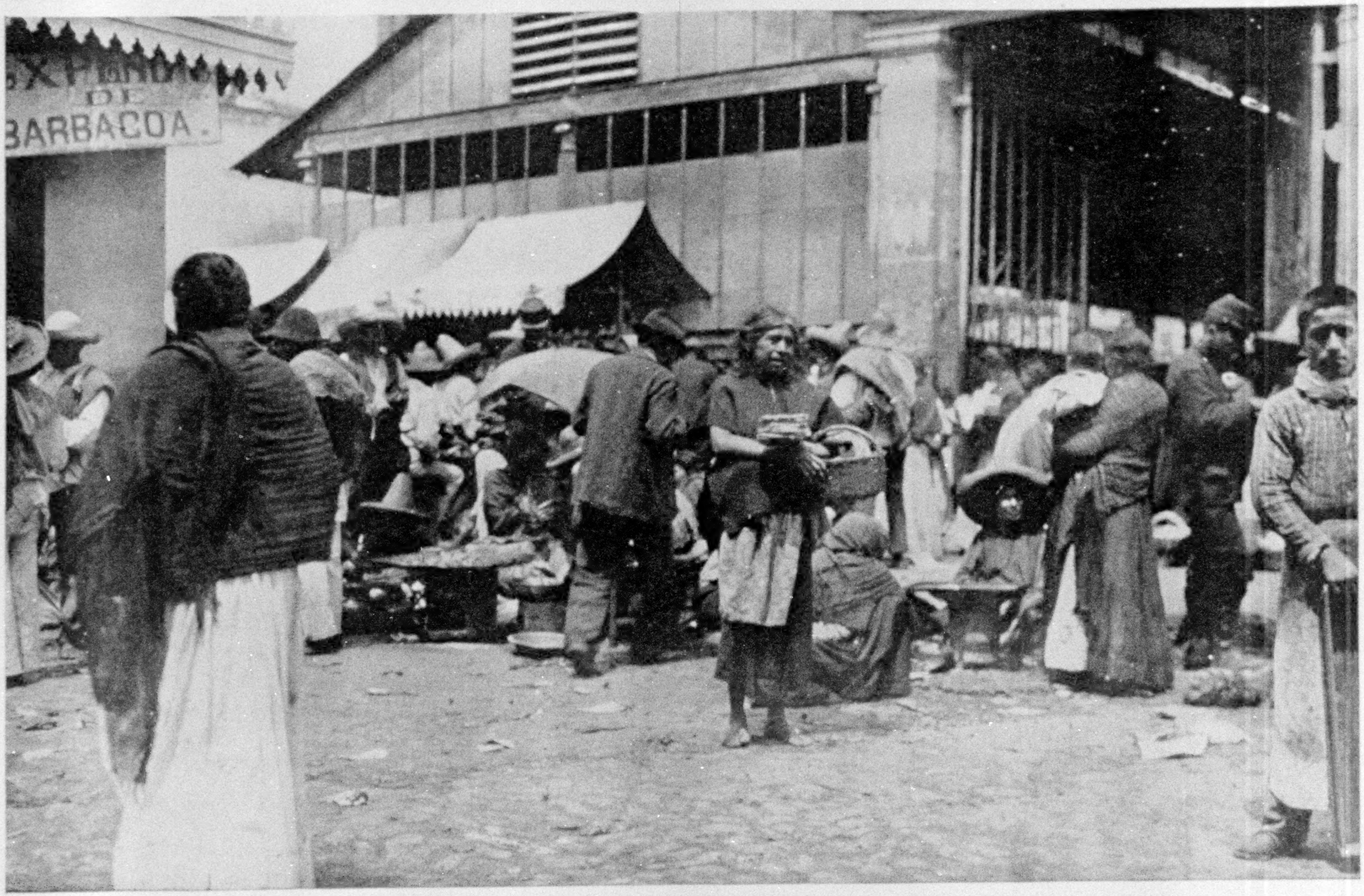


Photo by J. Langland

OLD INDIAN WOMAN IN THE MARKET-PLACE: CITY OF MEXICO

The Indian women come from far and near to the market day. It is no unusual sight to see one of them with a baby tied to her breast with a shawl, a load of wood in each hand, and a basketful of produce on her head

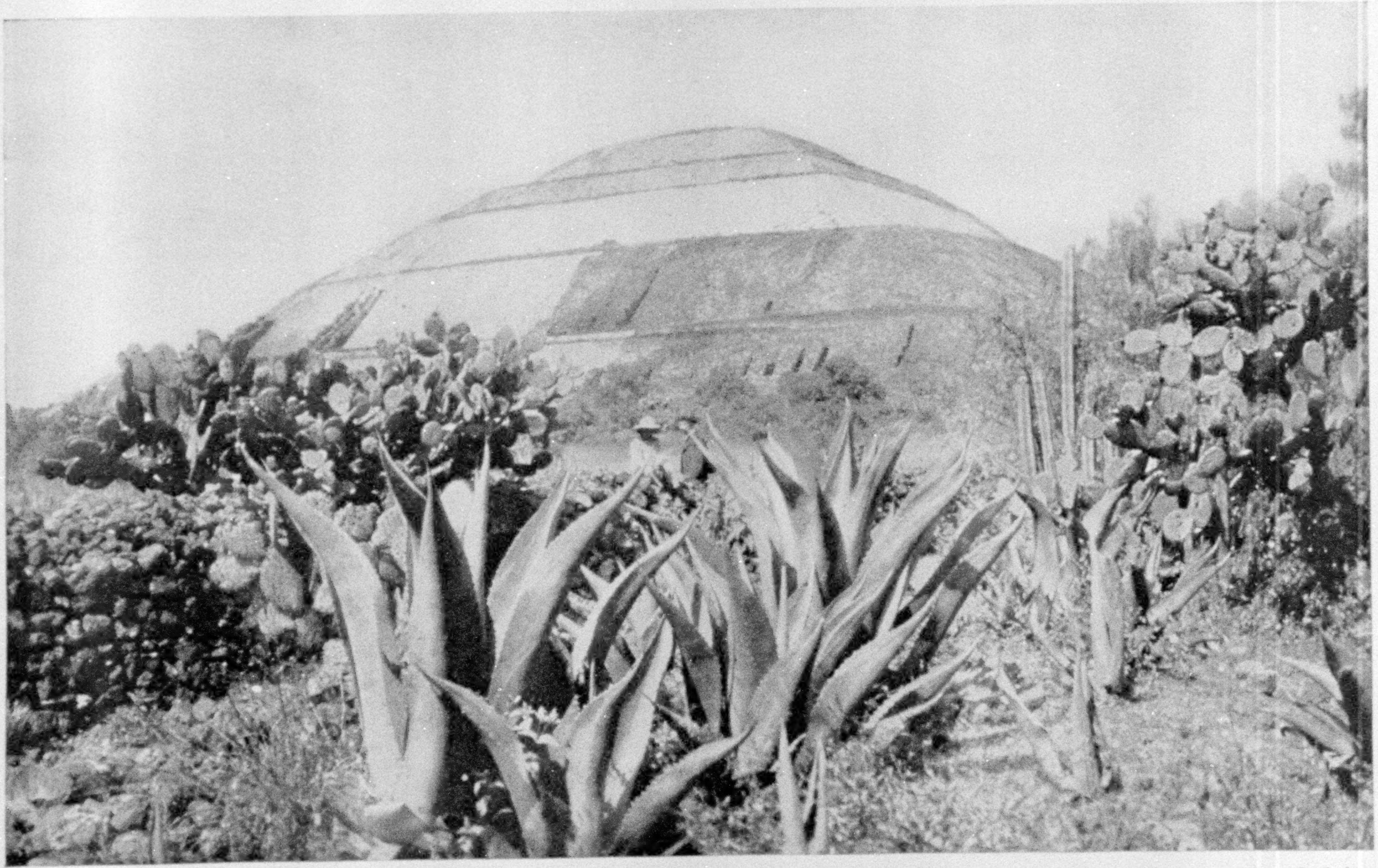


Photo from Alberto L. Godoy

THE PYRAMID OF THE SUN: SAN JUAN TEOTIHUACAN

On this pyramid the Chinese Minister to Mexico, in 1911, found an inscription which is common on the burial places of China. Skirting the west base is the Path of the Dead, flanking either side of which are tumuli, which, when opened, were found to contain wrought stone sarcophagi, inclosing human bones, obsidian knives, and terra-cotta heads, the latter supposed to be the effigies of buried priests and kings (see also page 636)

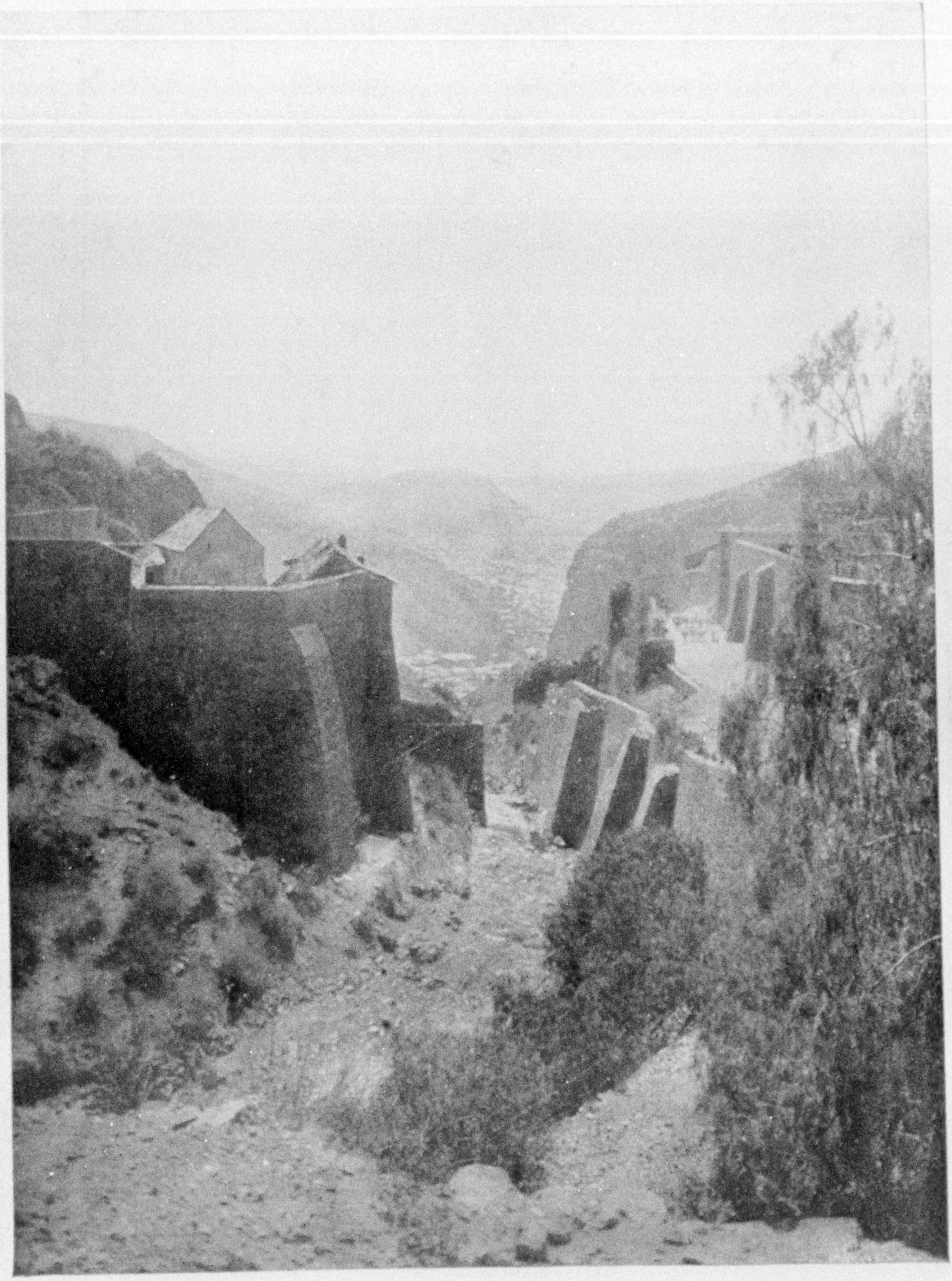
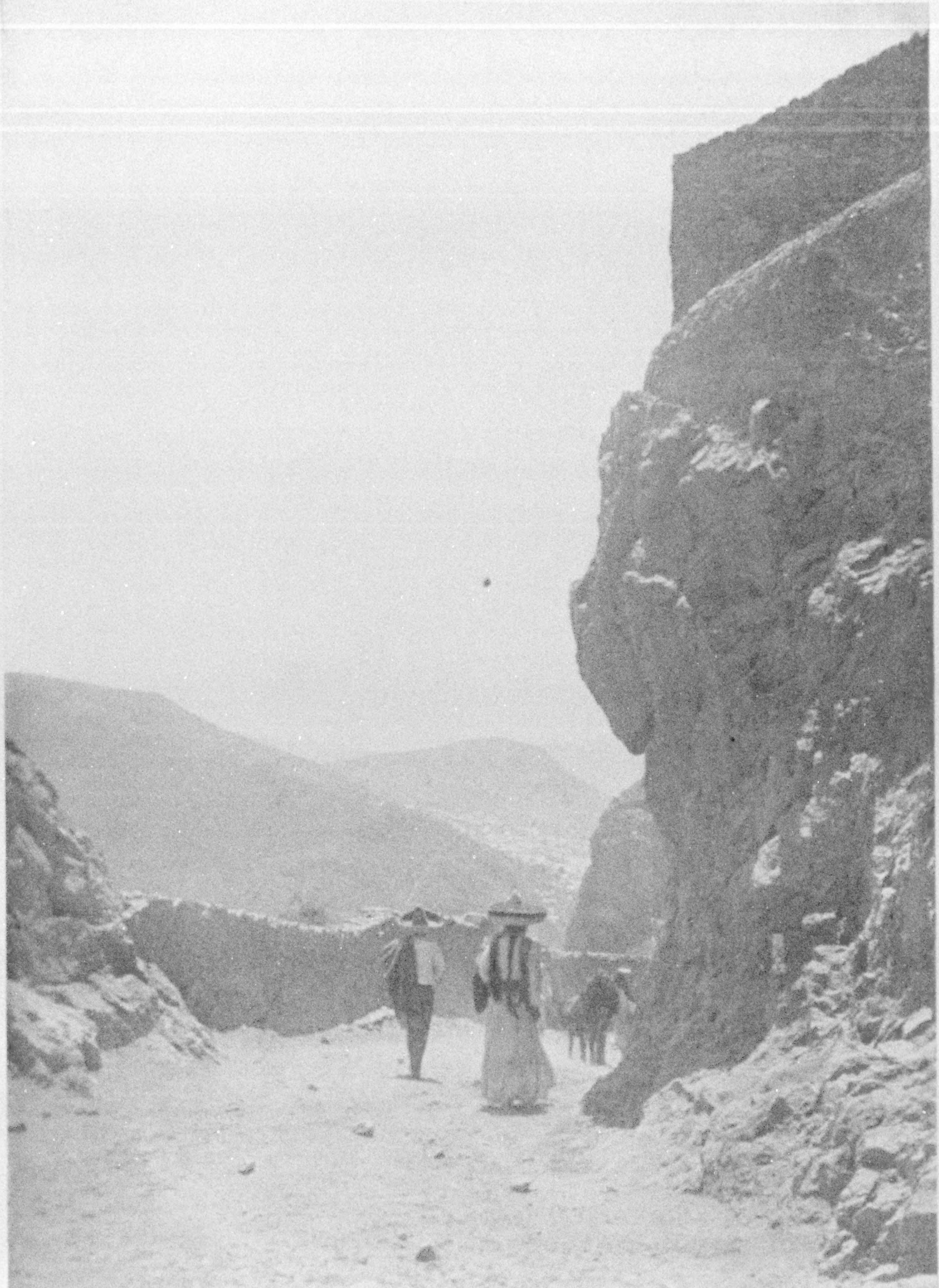


Photo from Alberto L. Godoy

ON THE ROAD TO PACHUCA, DECORATED HERE AND THERE WITH RUINS OF EARLY SPANISH TIMES

The Conquistadores were great builders, and in addition to the fortresses in and around Pachuca, one finds here the ruins of one of the three most celebrated aqueducts in Mexico, built by the Franciscan Friar Francisco Tembleque.



AN OLD MEXICAN HIGHWAY

Photo by Alberto L. Godoy

The highways of Mexico wind in and out of mountain passes as they cross from one valley to another, and strings of burros and files of Indians going to market or returning are a familiar sight. Pachuca may be seen in the distance.

XUM

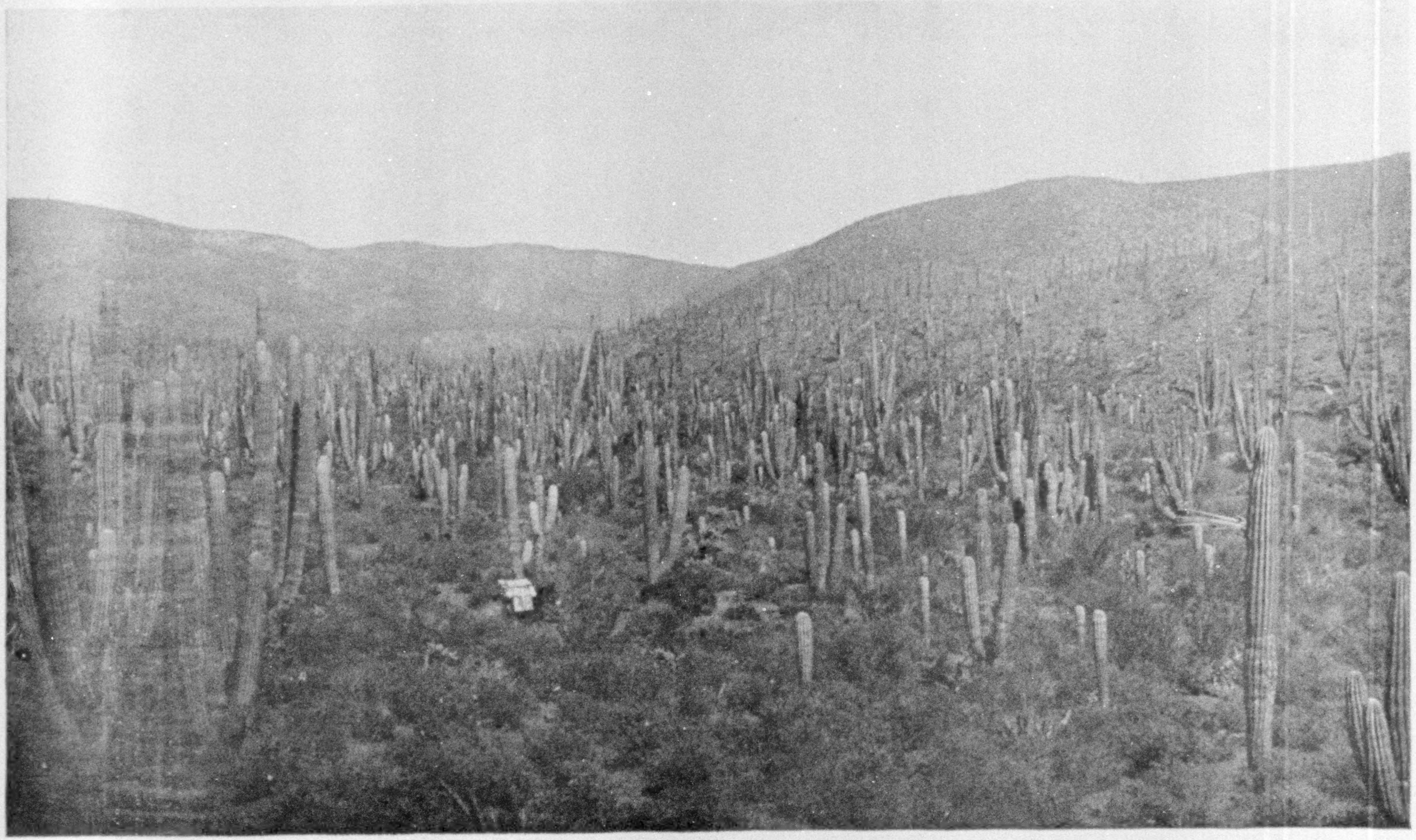


Photo by D. Basil W. Alexander

A FOREST OF CACTI IN THE UPPER END OF SAN VICENTE CAÑON IN LOWER CALIFORNIA, MEXICO

Millions of acres of the highland region of Mexico are too arid for other vegetation than the cacti and the sage-brush. The above scene is characteristic of the panorama that unfolds itself before the car window for hundreds of miles in the mainland highlands, as well as characteristic of the northern part of the Lower California Peninsula.

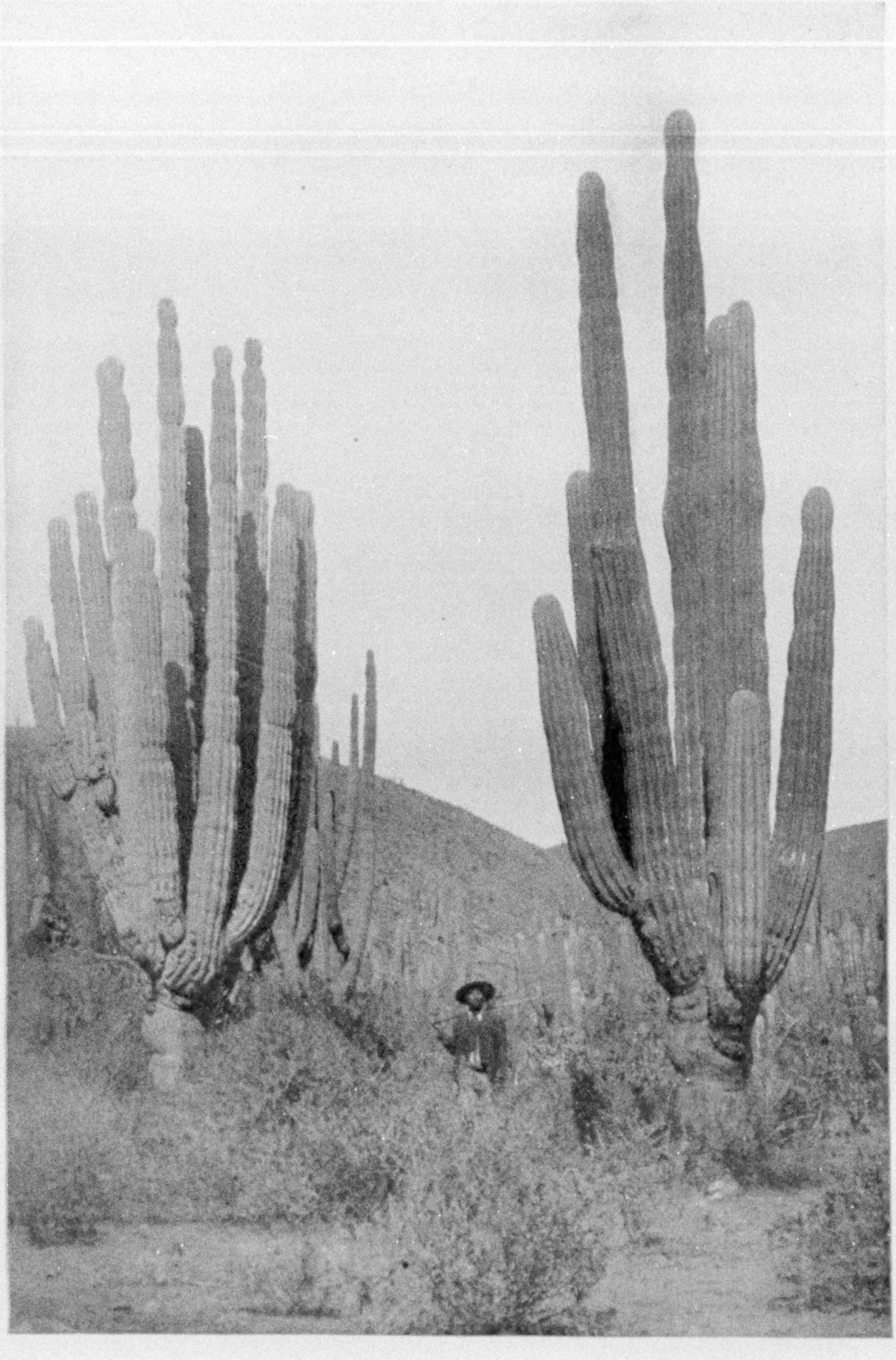


Photo by D. Basil W. Alexander

ANOTHER VIEW OF THE CACTI IN SAN VICENTE CAÑON, LOWER CALIFORNIA, MEXICO, SHOWING THEIR IMMENSE SIZE

Mexico has a majority of the more than 500 species of cacti, ranging from the *candelabra*, with its great branches, which give it its name, and the *organ*, with its fluted pipes and thorns with saw-tooth edges, to the creeping kinds that scarcely rise above the ground.

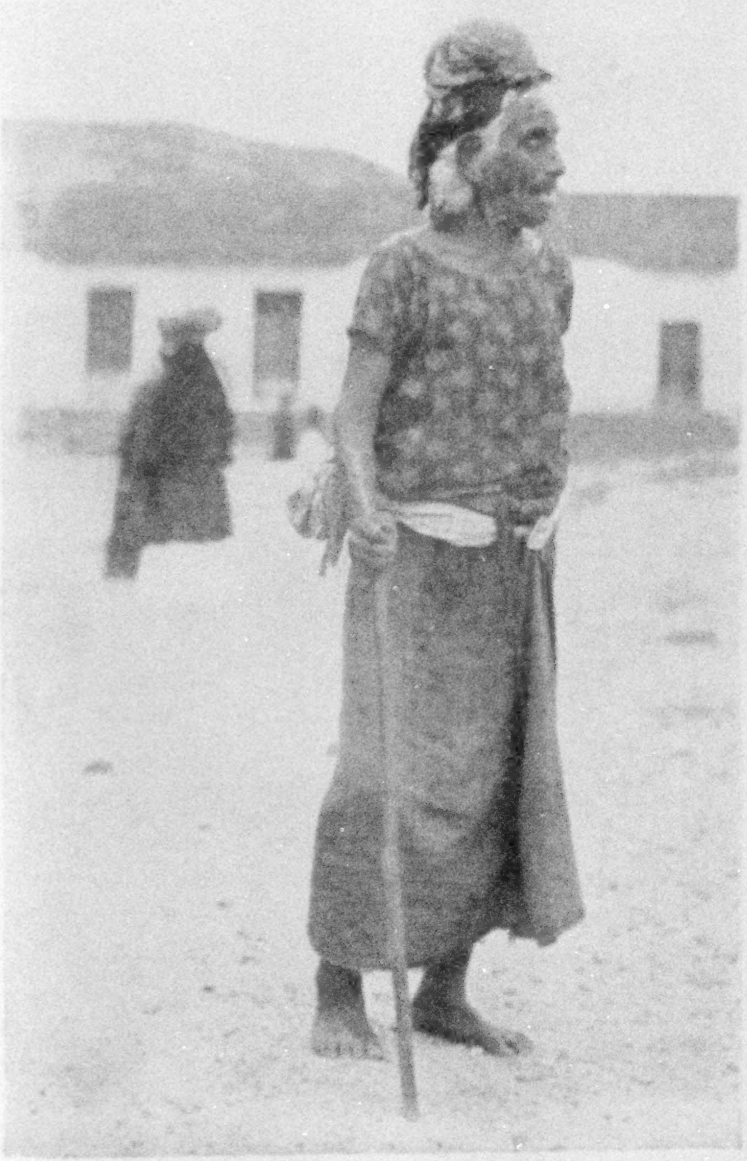


Photo by A. W. Cutler

A QUEER HEAD-DRESS

A Tehuana Indian beggar at Tehuantepec, Mexico. Her hat consists of half a cocoanut cleaned out and polished. A whole cocoanut can be purchased for something less than a penny.

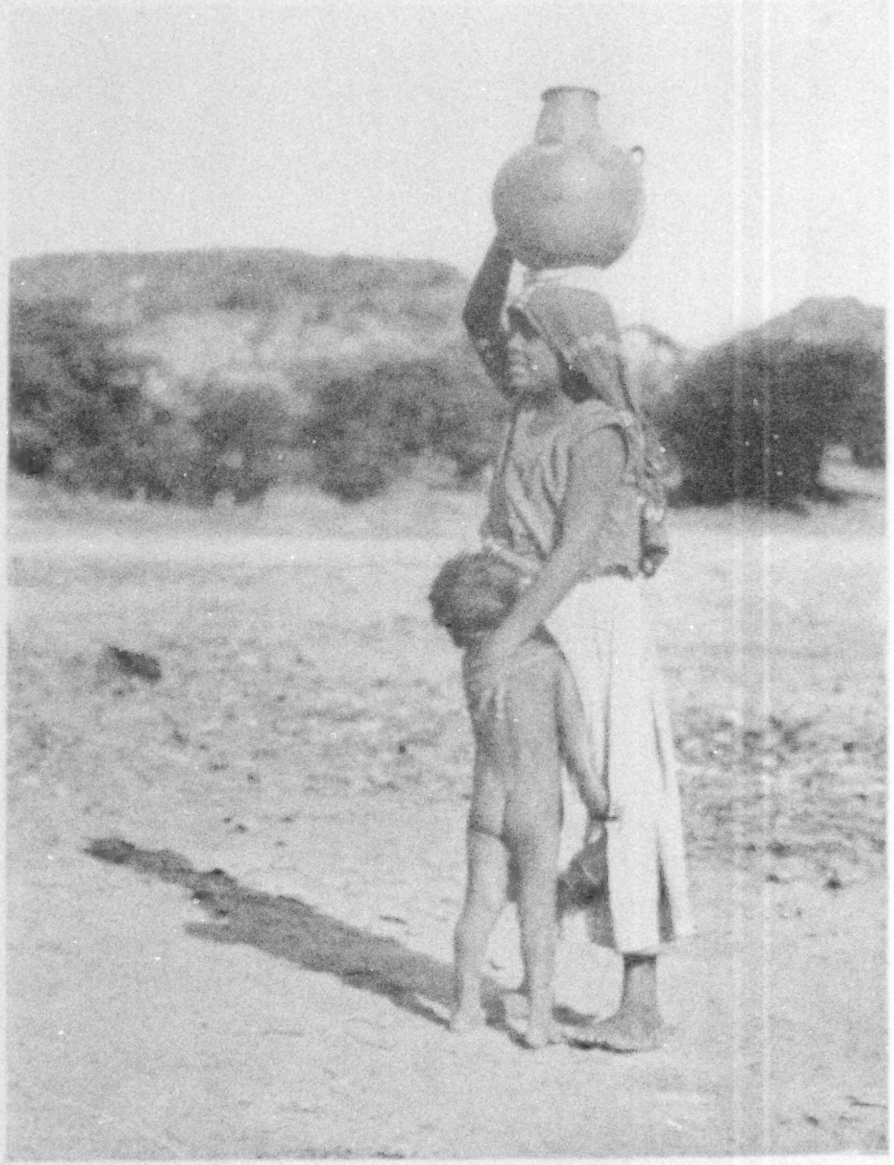


Photo by A. W. Cutler

THE WATER-CARRIER

One of the many methods of carrying water adopted by the Tehuana Indians of Tehuantepec, Mexico

XUM

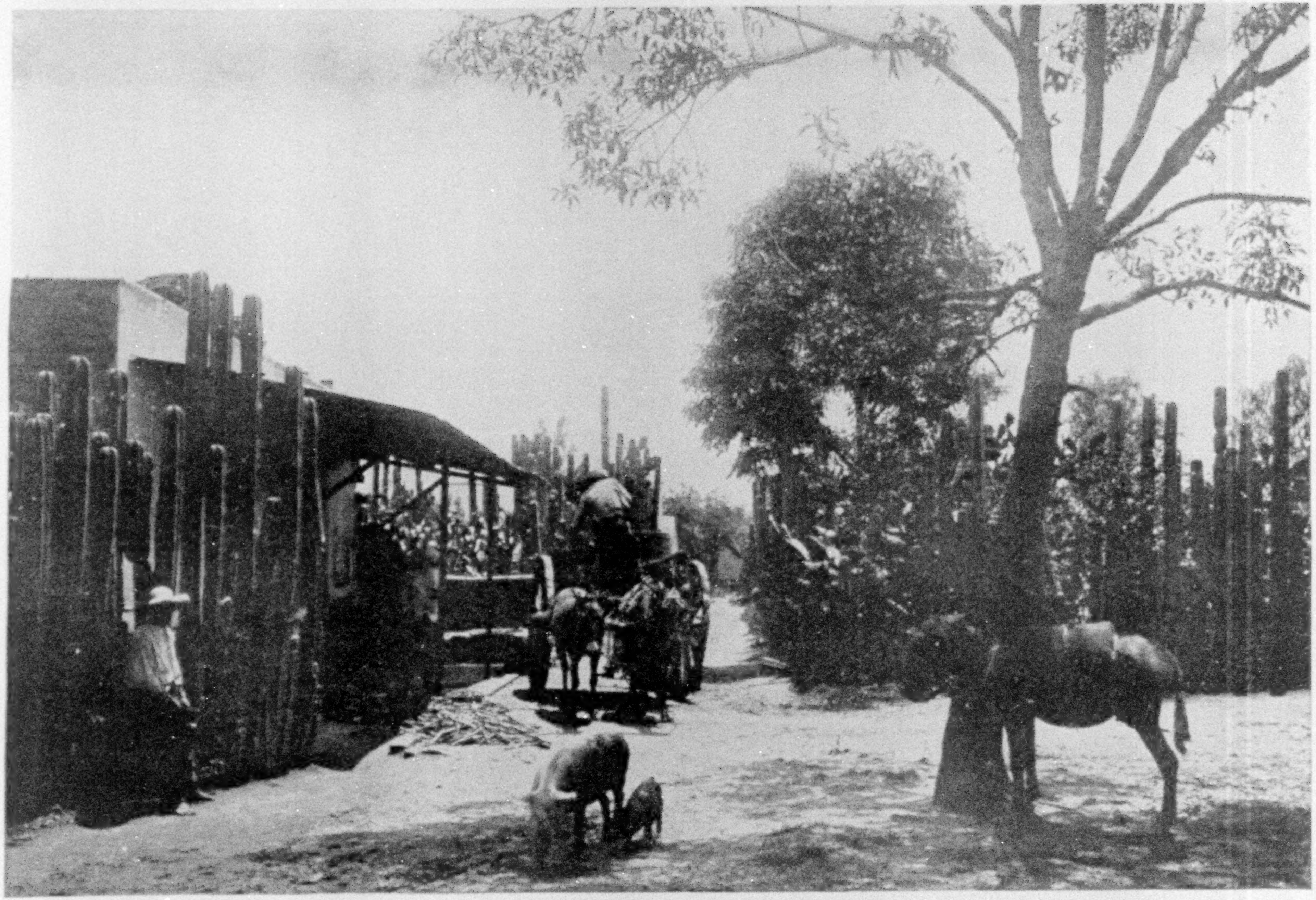


Photo from Alberto L. Godoy

IN THE SAN PABLO REGION, MEXICO

The small farmer of the semi-arid regions of Mexico has a rather disheartening fight for existence. His crops are limited in range, being mainly corn and beans, and they are usually short, affording him and his family only the barest necessities of life. Note the fences of cactus.

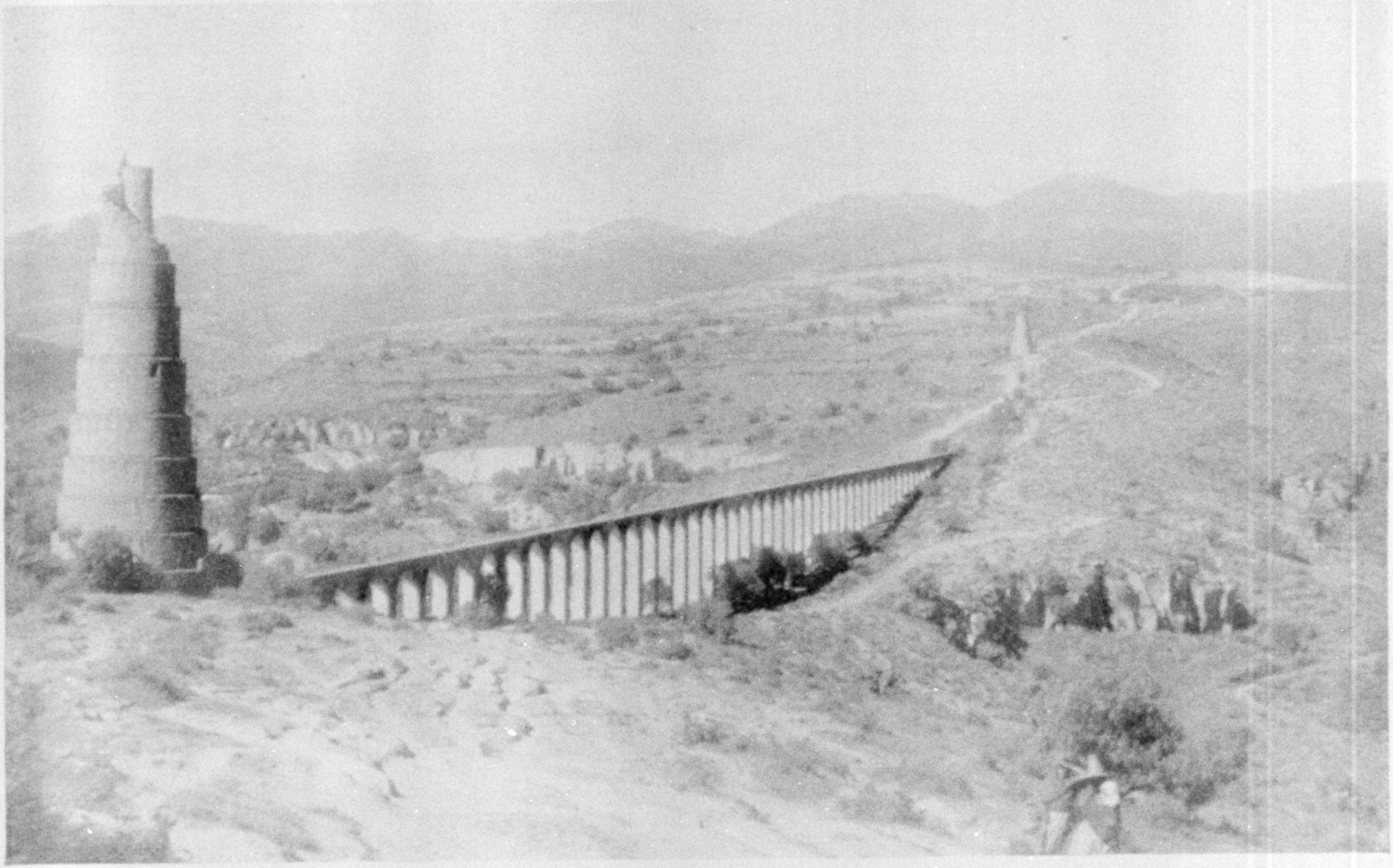


Photo from Alberto L. Godoy

WATCH-TOWERS OF THE AQUEDUCT OF THE REMEDIES

Highland Mexico abounds in aqueducts which carry water long distances. Some of them have watch-towers, where sentries are stationed to protect them

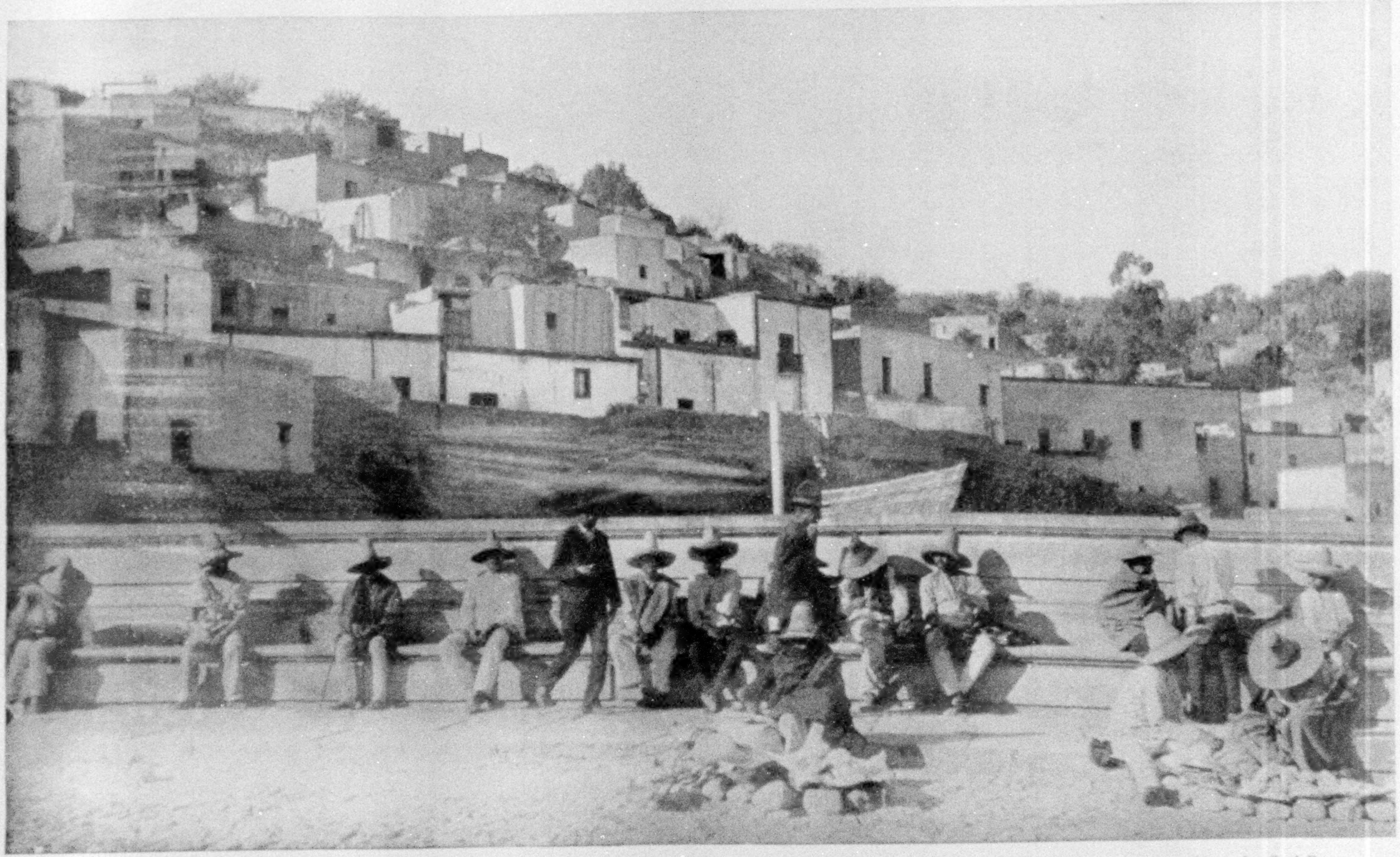


Photo by Carl Bergmann

THEY LOVE THE SUN

In the highland cities of Mexico the poor congregate in the small plazas and contentedly sun themselves, getting the chill of the cold and coverless nights out of their bodies. The quick-lunch counter is always there to cater to their wants, even though they have very little money to spend.

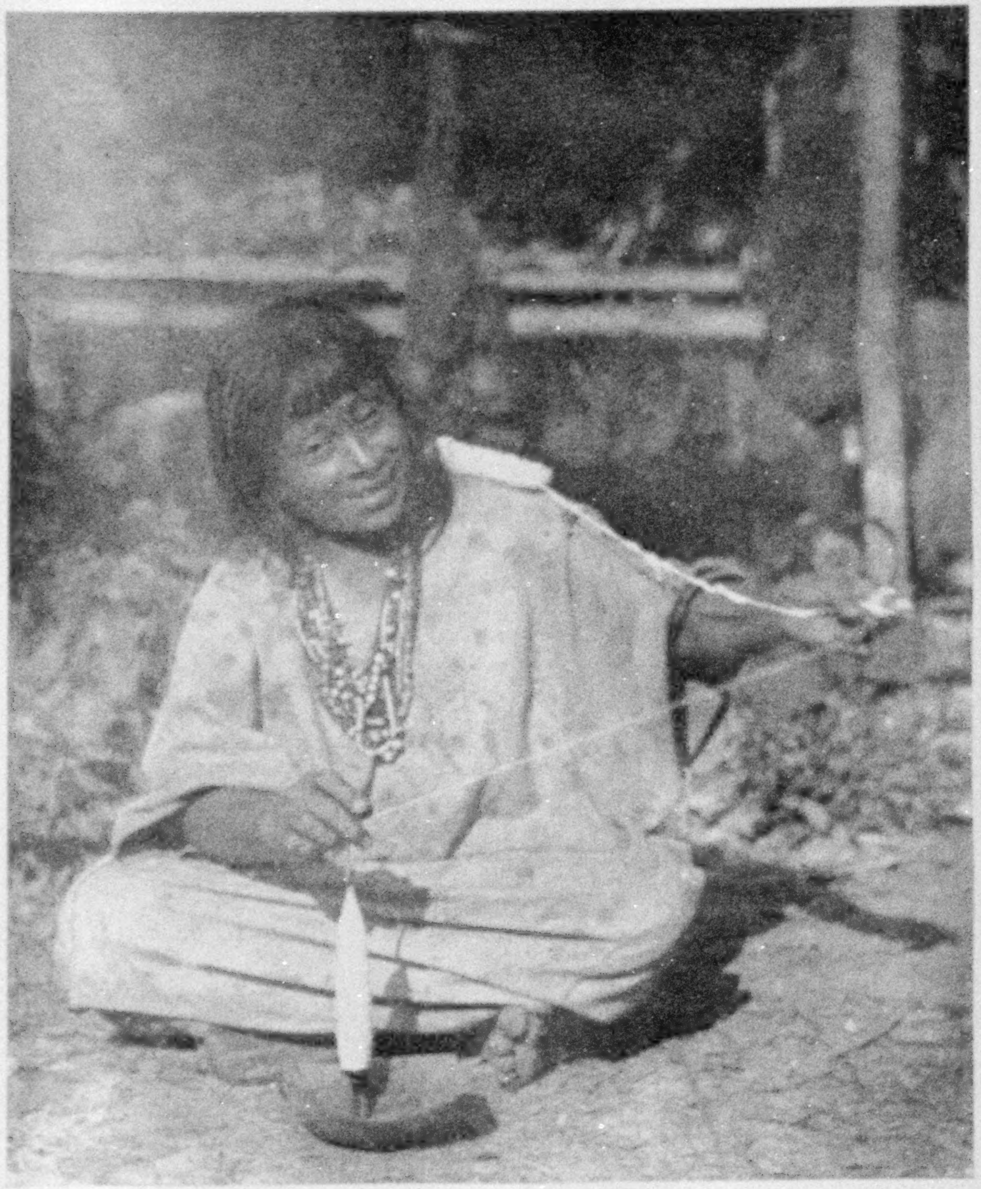


Photo by C. M. Tozzer

LACANDONE WOMAN SPINNING THE NATIVE COTTON

The spindle rests in a gourd and the mass of crude cotton rests on the shoulder: Yucatan

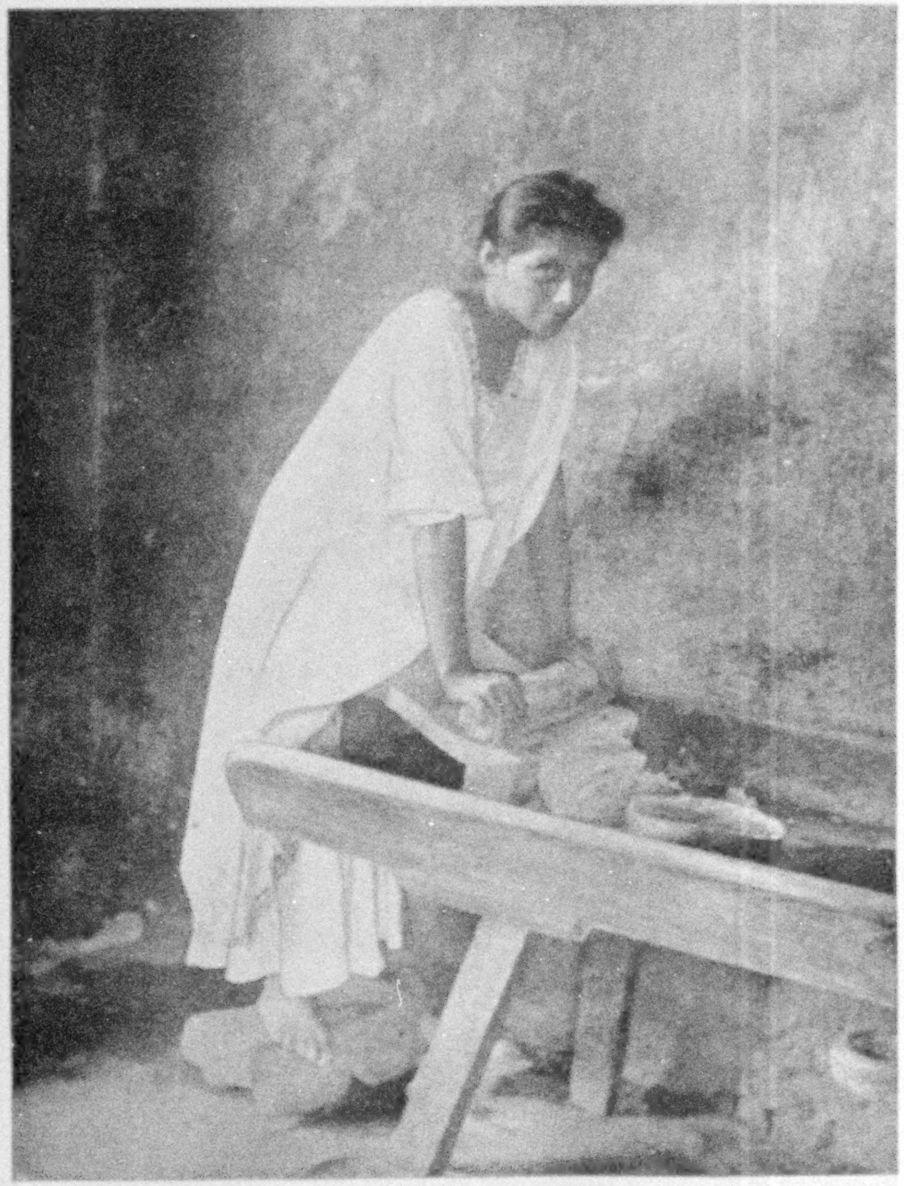


Photo by C. M. Tozzer

A MAYA WOMAN GRINDING CORN WITH A STONE METATE

She is the descendant of a proud race that is said to have been the only one of the Western World that made any progress toward a phonetic system of writing. They were conquered by the Spanish in the great battle of Merida, in 1540, and every possible remnant of their civilization put to the torch (see page 606).

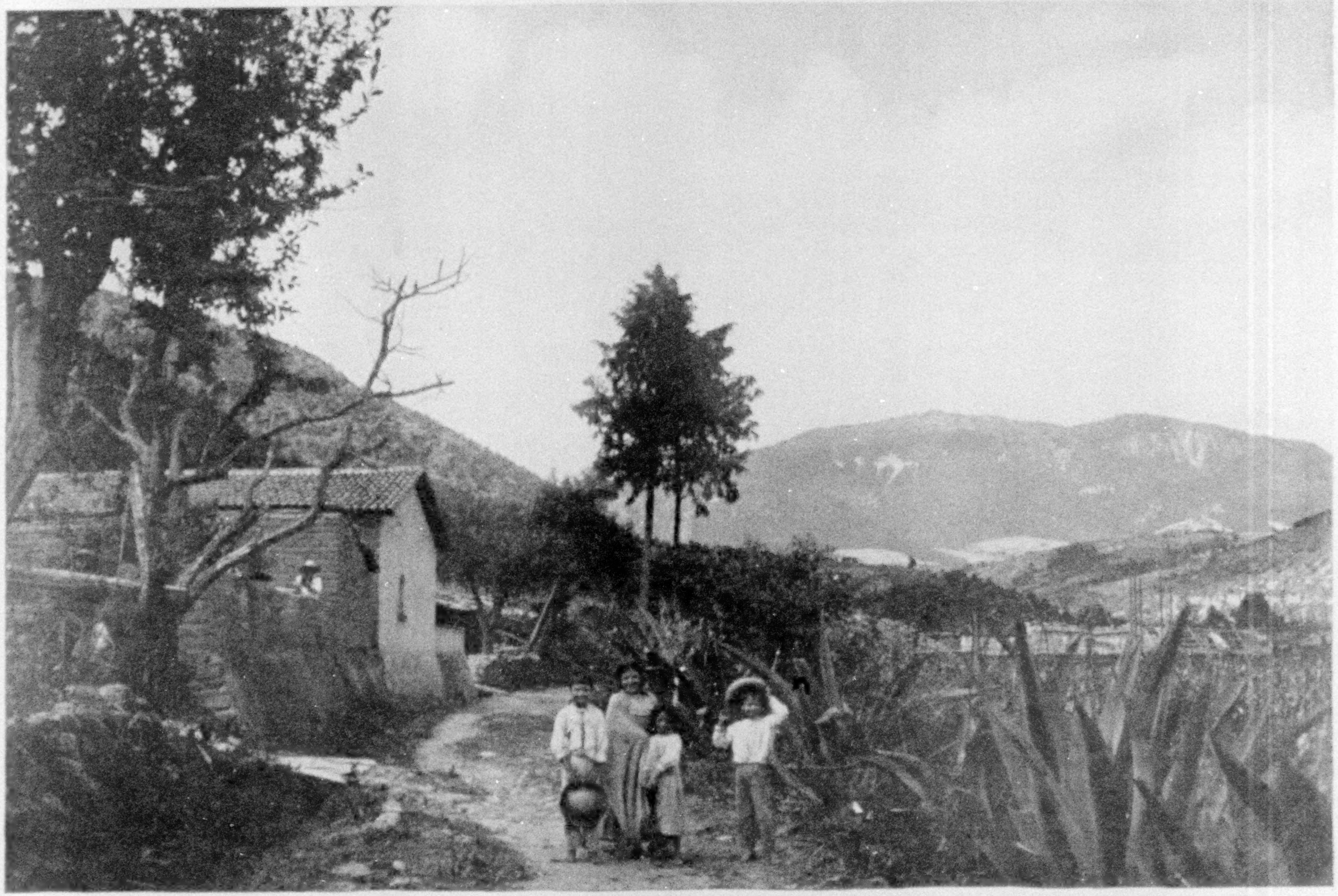


Photo from Alberto L. Godoy

A HAPPY QUARTETTE: SAN BARTOLITO

For a care-free existence, the children of the Mexican peons match the birds. They may be as dirty as the pigs that share their quarters, as ignorant as the dogs that are their playmates, but nevertheless they are apparently a happy and contented lot

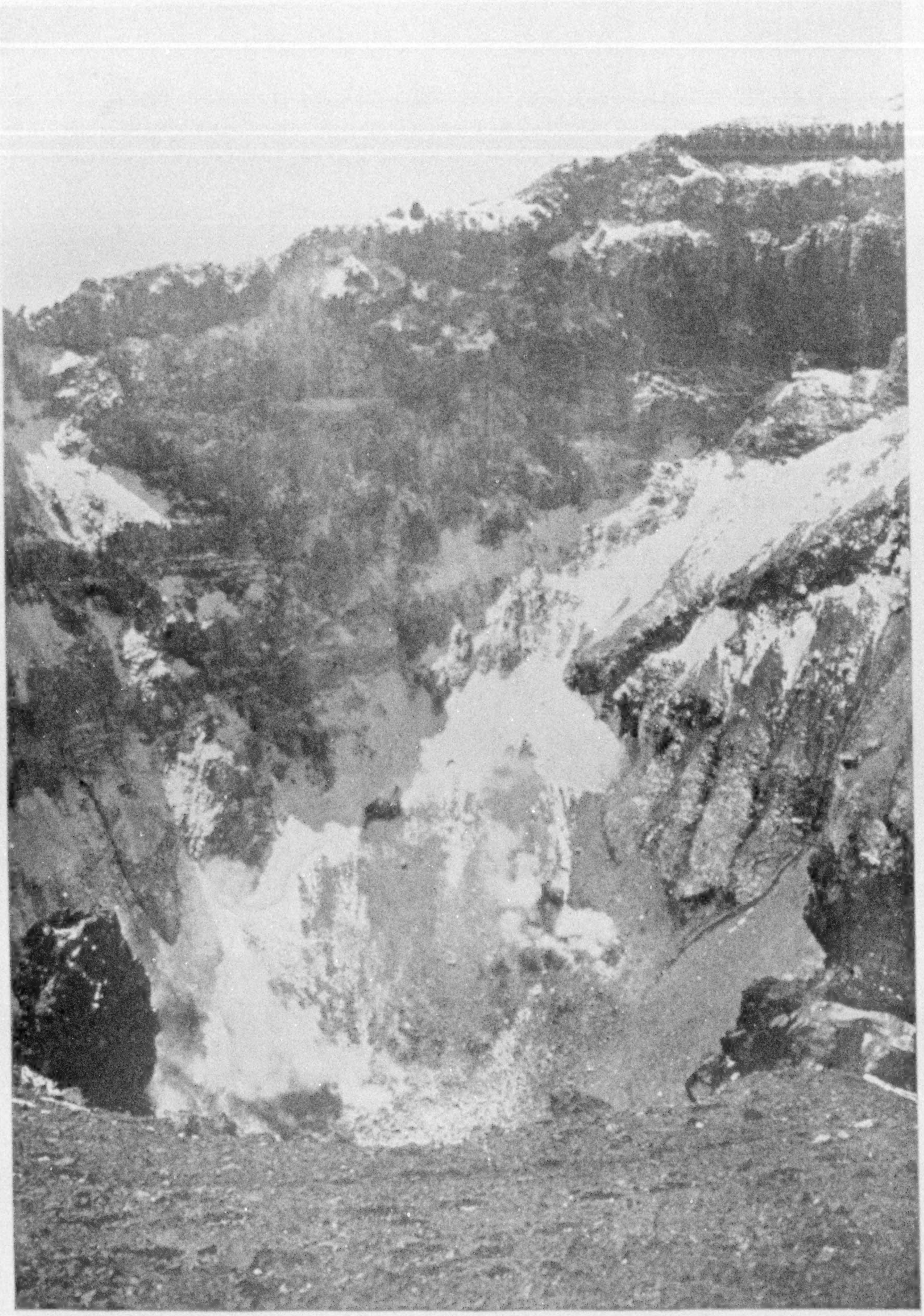


Photo from Alberto L. Godoy

POPOCATEPETL'S CRATER

This crater is bell-shaped instead of conical. Many thousands of tons of sulphur have been taken out of it and the supply seems inexhaustible. The sulphur is carried up 500 feet by peons, who climb "chicken ladders." A windlass takes it the remainder of the distance to the top. Here the peons put it on mats and slide to the lower edge of the snow-line with it. The peak of this famous mountain is shown on page 641.

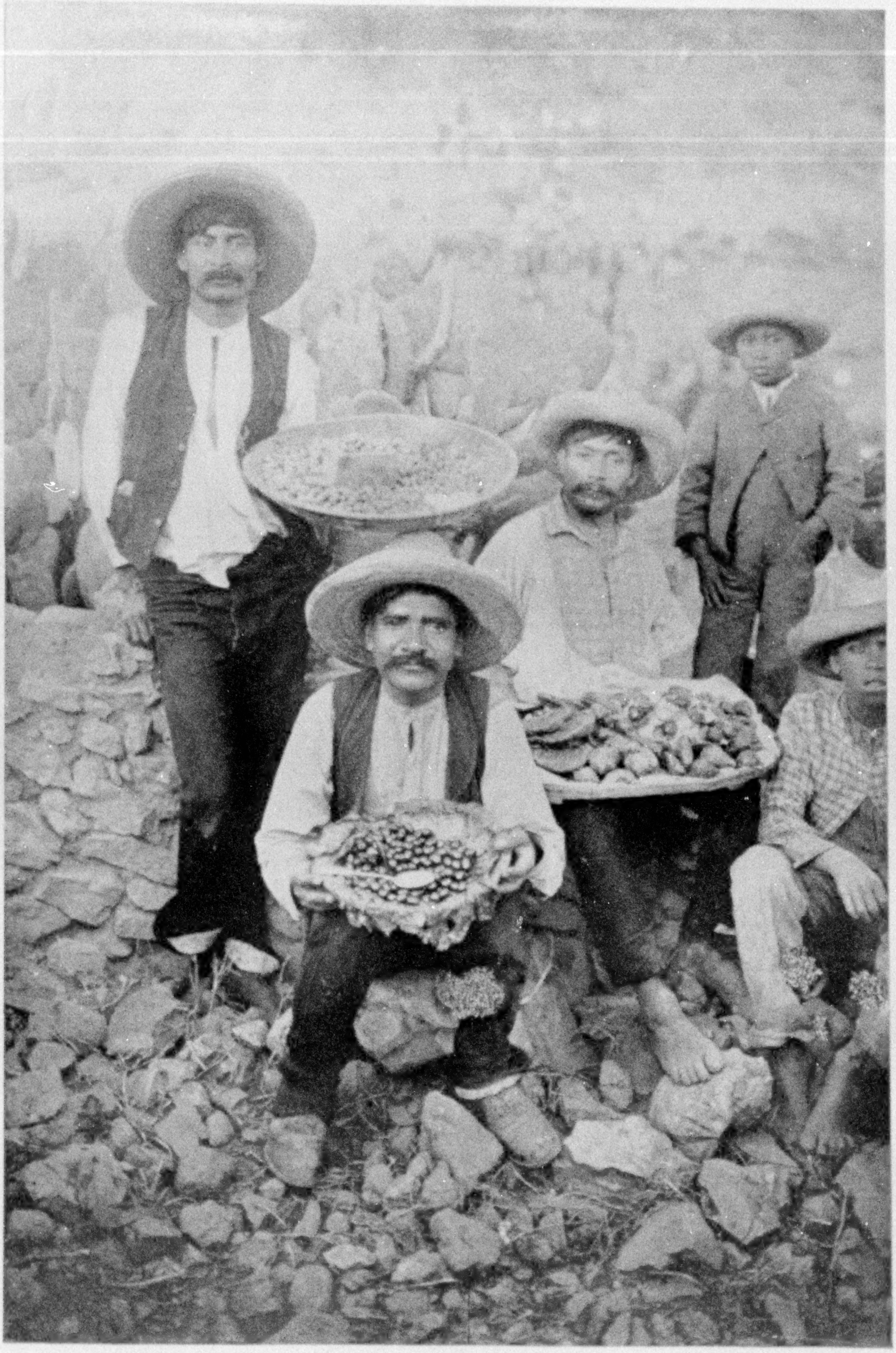


Photo from Alberto L. Godoy

PEANUT AND SWEETMEAT VENDERS

Nature's "original sealed-package" goods find favor with the traveler after seeing the indifference of the sweetmeat venders to flies and dust, which have free access to their offerings.

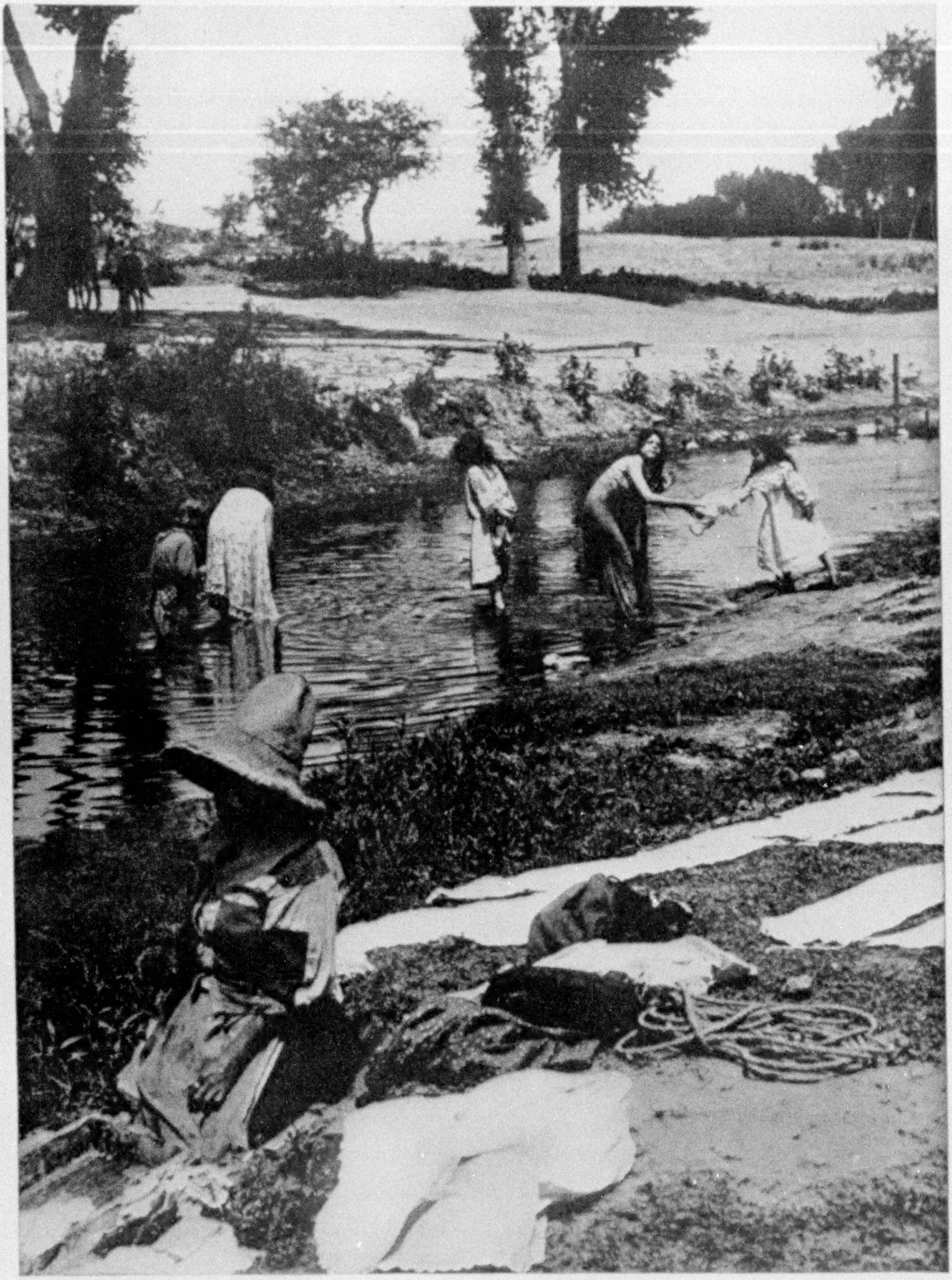
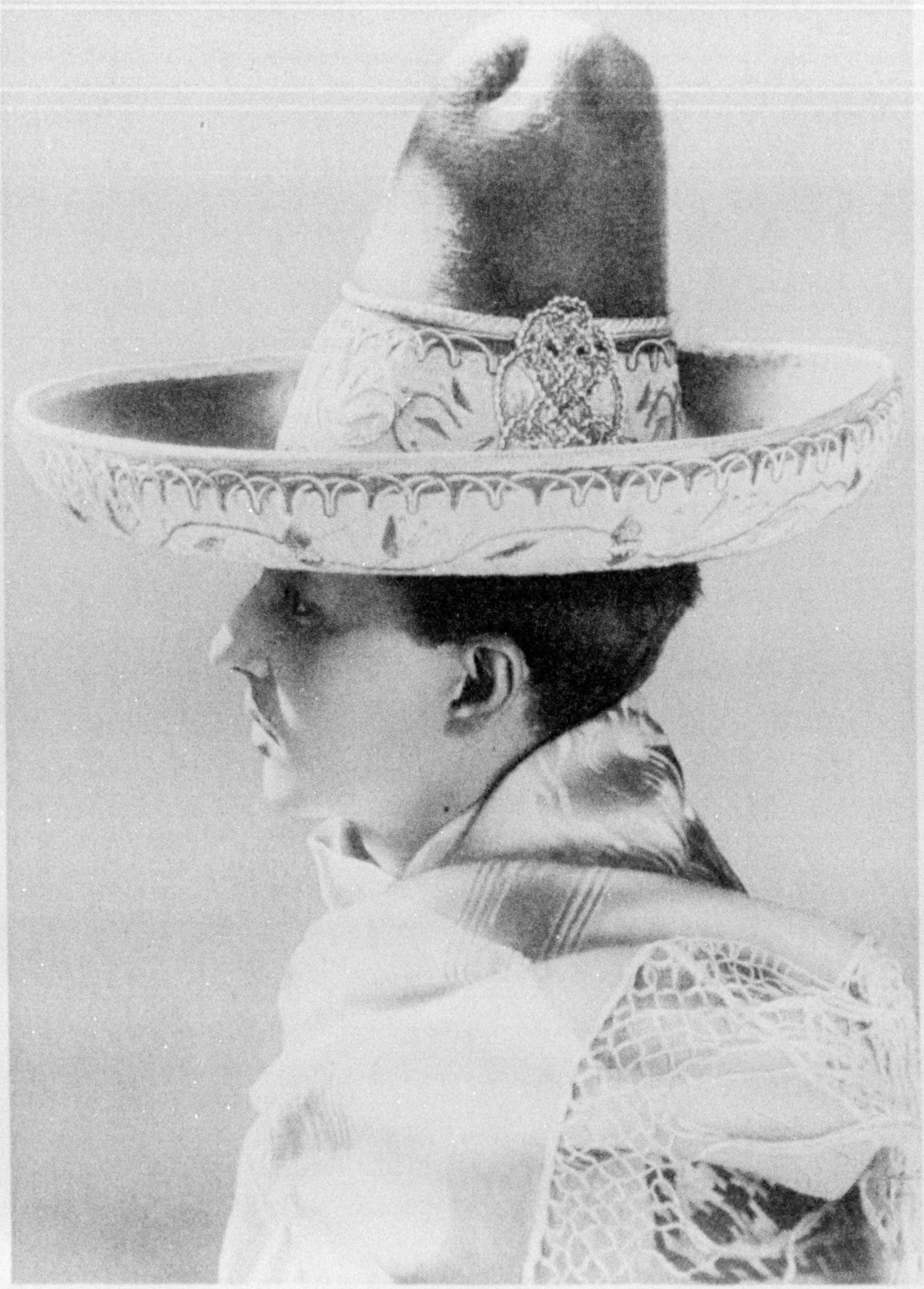


Photo and copyright by Underwood & Underwood

WASHING AND BATHING IN THE STREAM FED BY THE HOT SPRINGS: AGUASCALIENTES, MEXICO

There is one phrase a traveler always remembers in Mexico—"agua caliente." It means "hot water," a boon that can be had only at a hot spring or through the aid of an alcohol lamp.

XUM

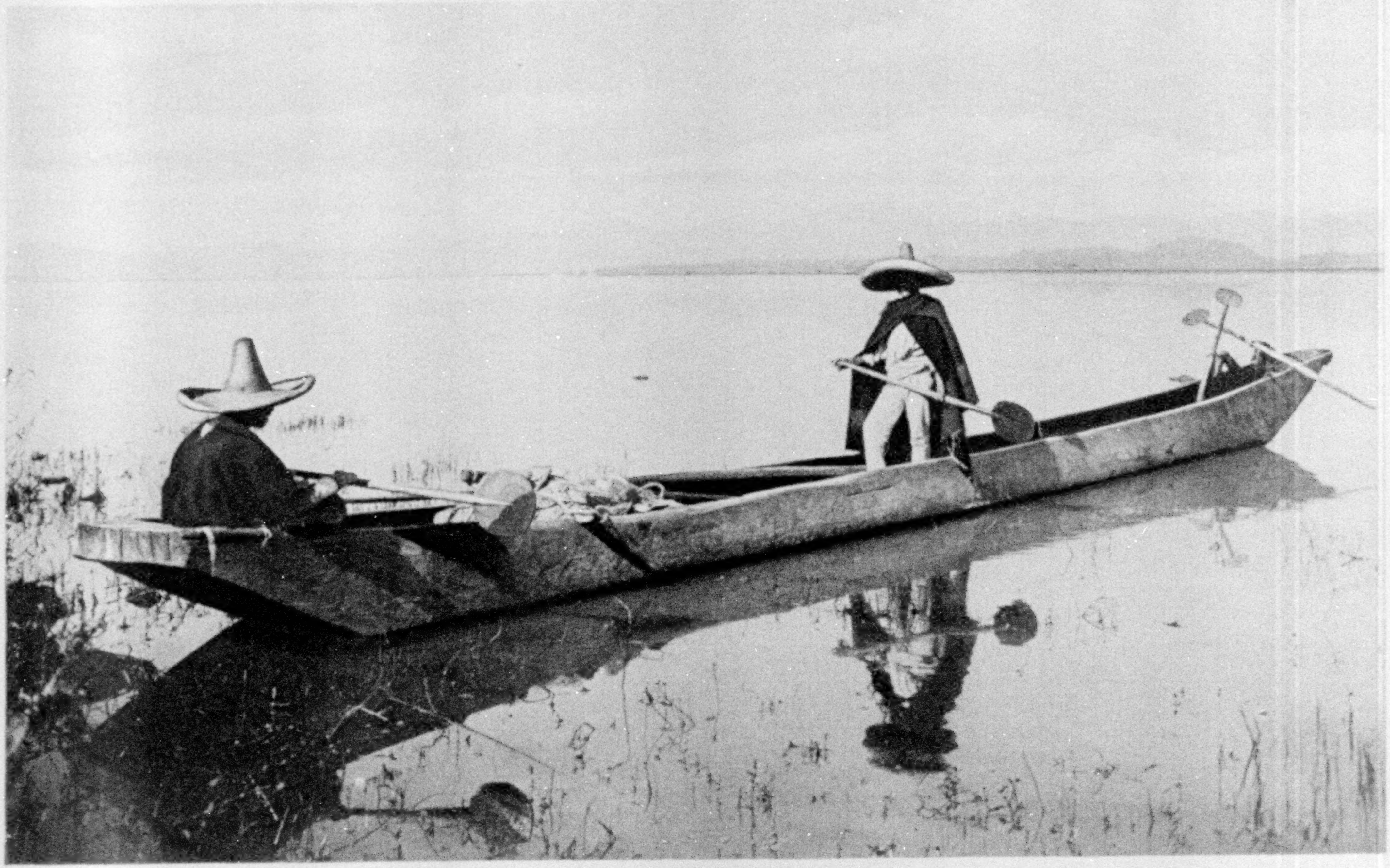


MEXICAN CHARRO AND HIS HAT

Photo from H. Ravell

What leather breeches and "chaps" with their elaborate fringes mean to the American cowboy of the old school, the big sombrero means to the "man on horseback" in Mexico. His hat may cost half as much as his horse, and his sarape may match the rainbow for colors. When the elder Diaz attired his "rurales" in such a uniform there was always a waiting list.

XUM



ON LAKE PATZCUARO, IN THE STATE OF MICHOACAN, MEXICO

Photo from Alberto L. Godoy

With its surface a mile and a quarter above the sea, and with a circumference of thirty miles, Lake Patzcuaro is one of the most beautiful inland lakes in the world. It abounds in water fowl, and many fishing and hunting expeditions are made to it by the Tarascan Indians.

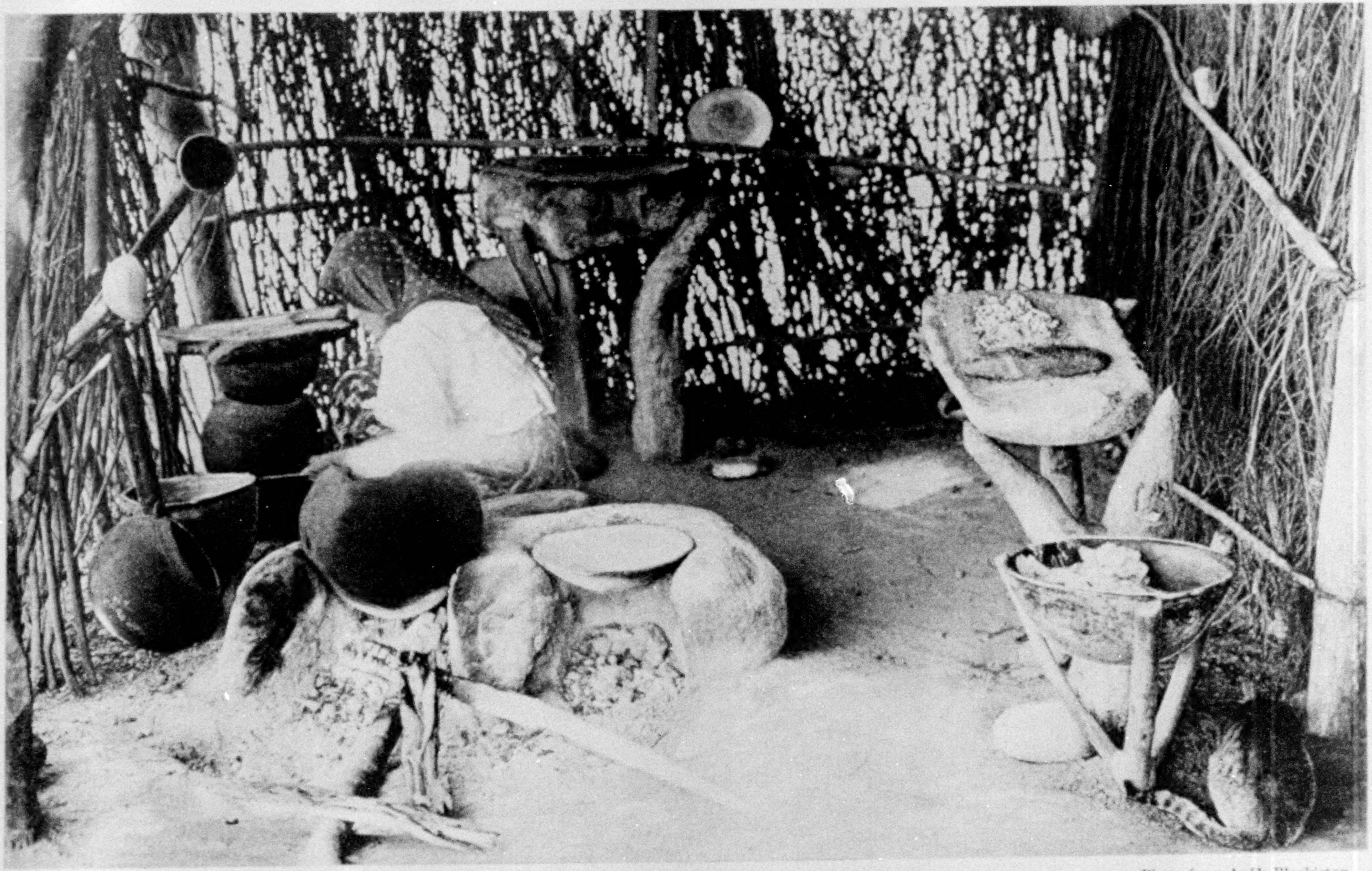
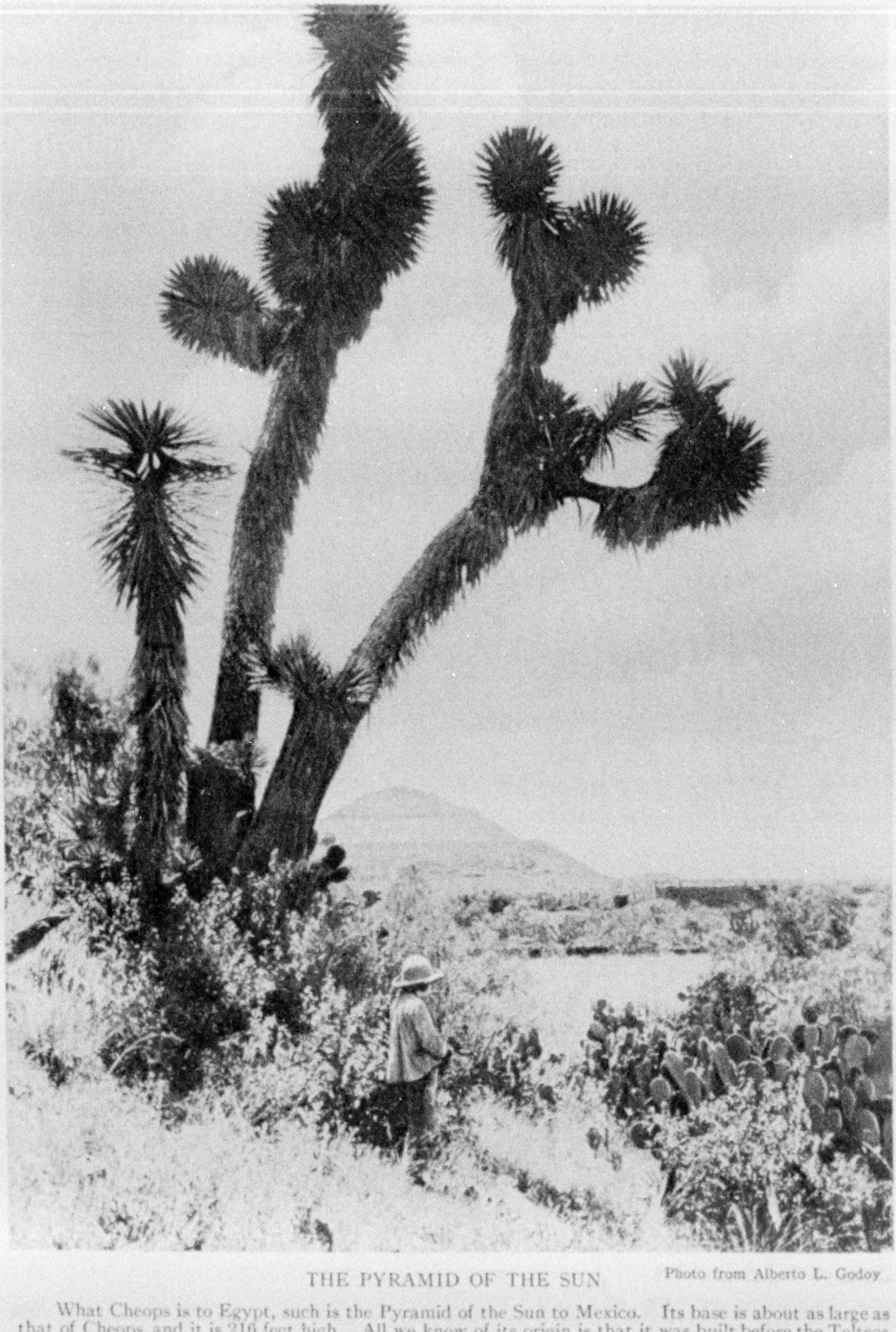


Photo from A. H. Blackiston

A RURAL KITCHEN IN MEXICO

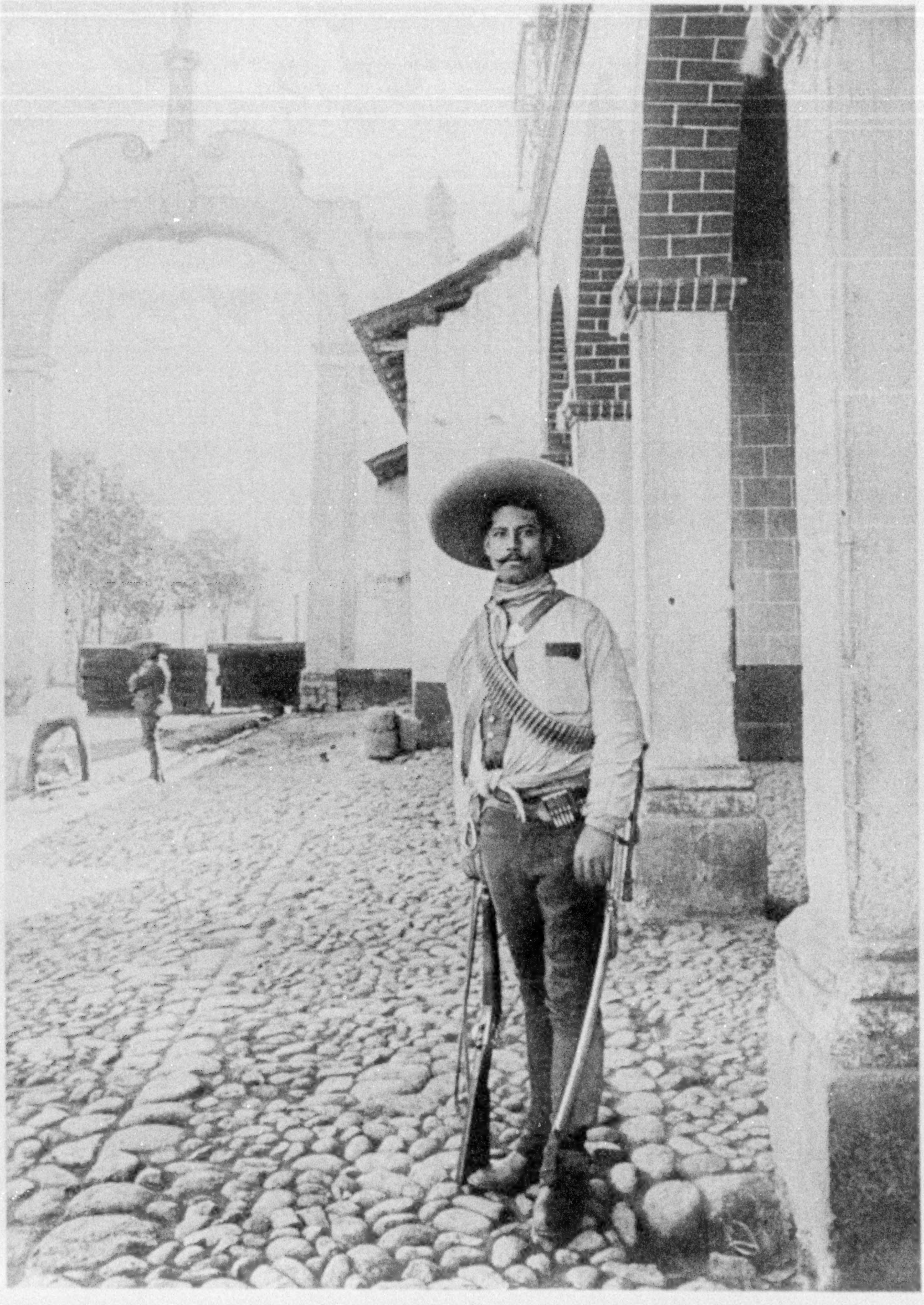
The kitchens of rural Mexico may not measure up to the standard of those of the rural American housewife, but the Mexican would not trade his hot tamales, chili concarne, frijoles, and tortillas for the best chicken, ham, asparagus on toast and light rolls that the American housewife can prepare.

XUM



THE PYRAMID OF THE SUN Photo from Alberto L. Godoy

What Cheops is to Egypt, such is the Pyramid of the Sun to Mexico. Its base is about as large as that of Cheops, and it is 216 feet high. All we know of its origin is that it was built before the Toltecs occupied the Valley of Mexico. According to tradition, a splendid temple once crowned its summit, and contained a great monument to the sun made from a single block of porphyry. Excavations have revealed galleries and vaults like those of Cheops, and Senor Garcias Cubas, the eminent archeologist, says that a gallery in the companion pyramid, that of the moon, coincides exactly with the magnetic meridian.



A RURAL GUARD ON DUTY

Photo from Alberto L. Godoy

When Porfirio Diaz came into power the country was infested with robbers from the mountains to the sea. He selected the best and made a rural guard out of them. They justified his hopes, and after a while it became as safe to travel in Mexico as it is to travel in the United States. The prolonged civil strife has sadly thinned their ranks, however.

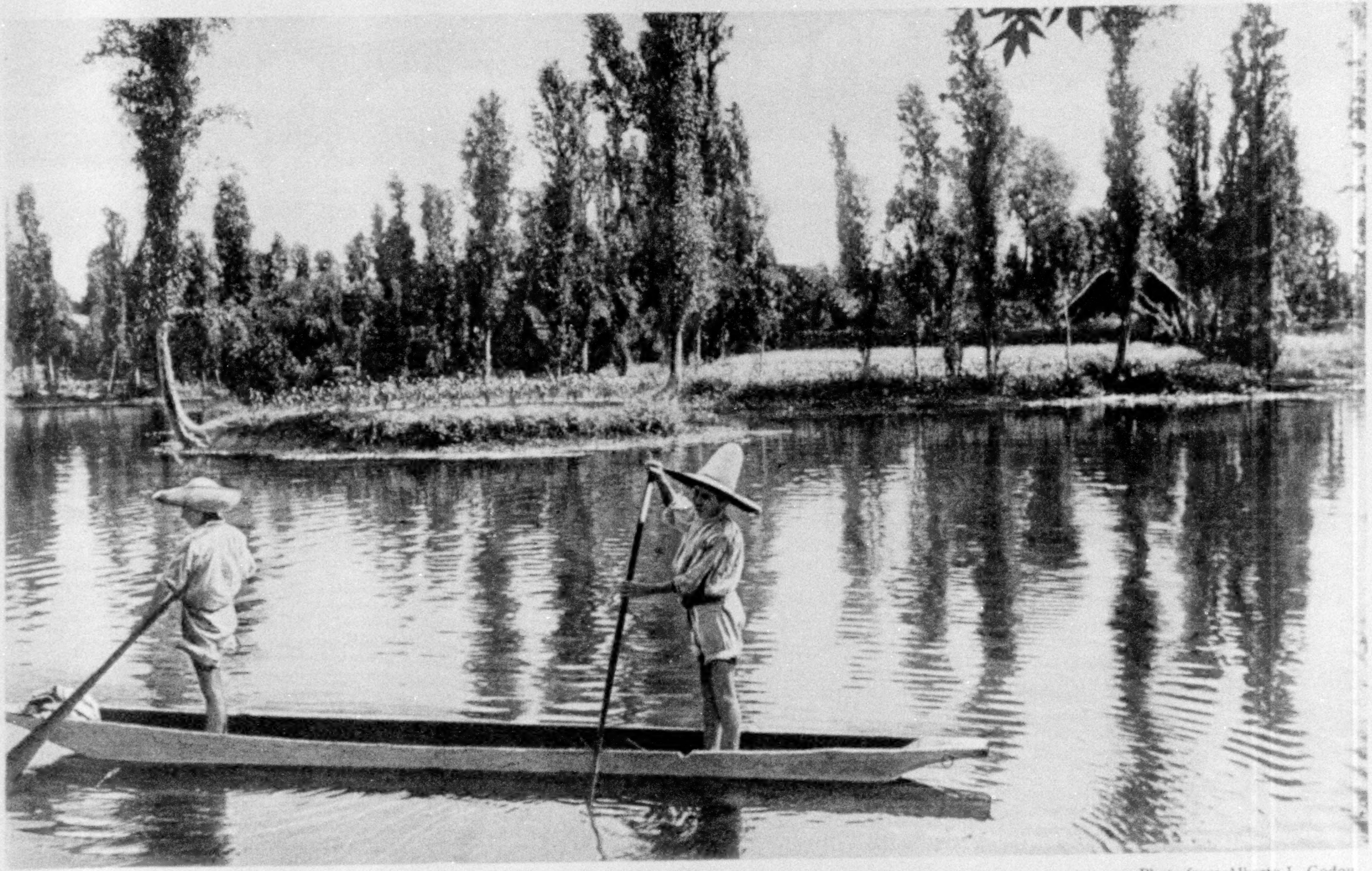


Photo from Alberto L. Godoy

CHILDREN BOATING ON XOCHIMILCO

The vicinity of Mexico City is famous for its lakes, and one of the most beautiful of them is Xochimilco. Some of these lakes were drained in the days of Diaz to prevent the inundation of the Capital in flood time.

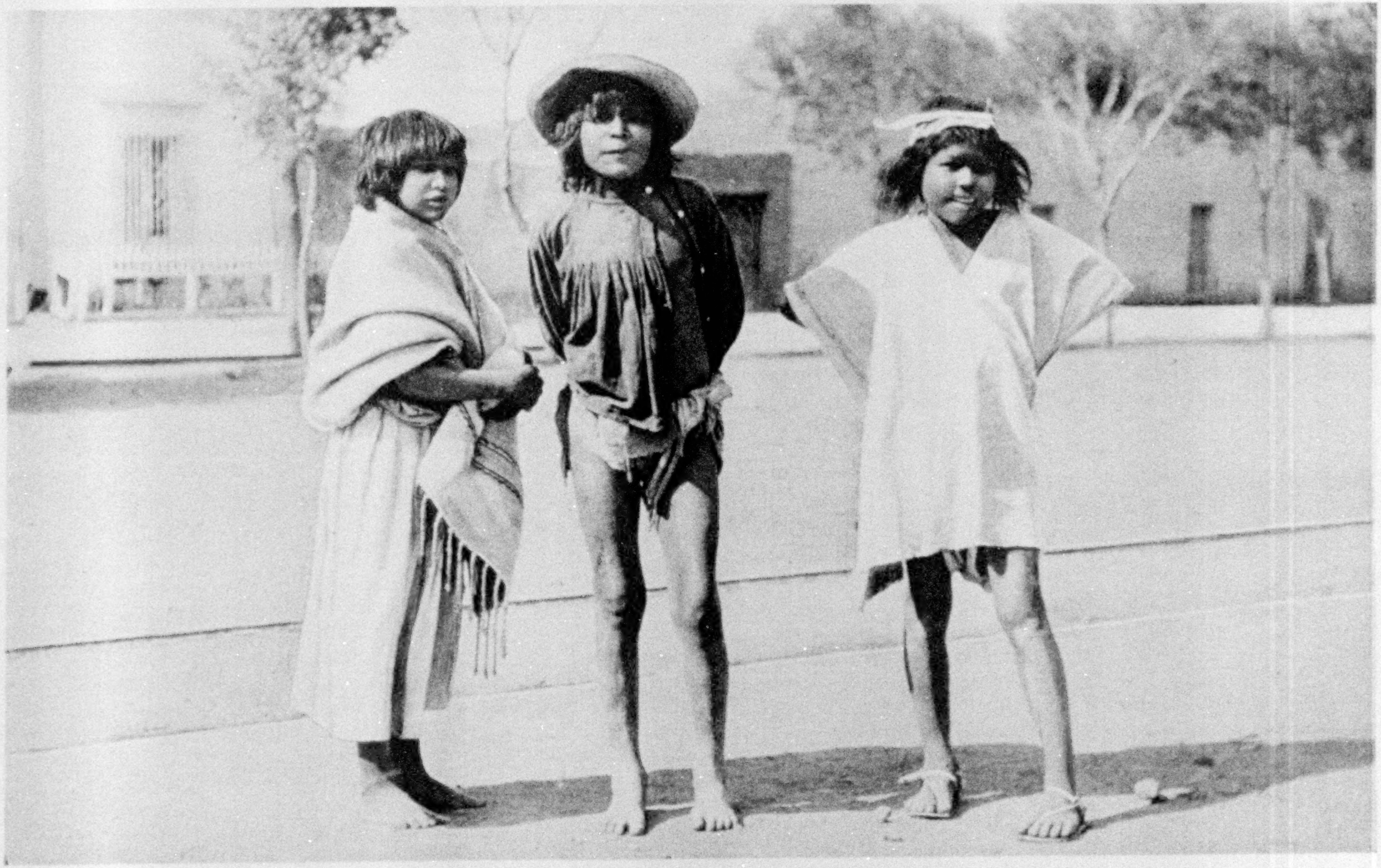


Photo from Carl Bergmann

THE HAPPY MEXICAN INDIAN

Left to himself and not forced to comply with the trammelling conditions of civilization, the Mexican Indian worries neither about the past, the present or the future. He finds that "sufficient unto the day is the evil thereof," and so he eats when he can, drinks when he pleases, and is merry when it suits him to be.

XUM

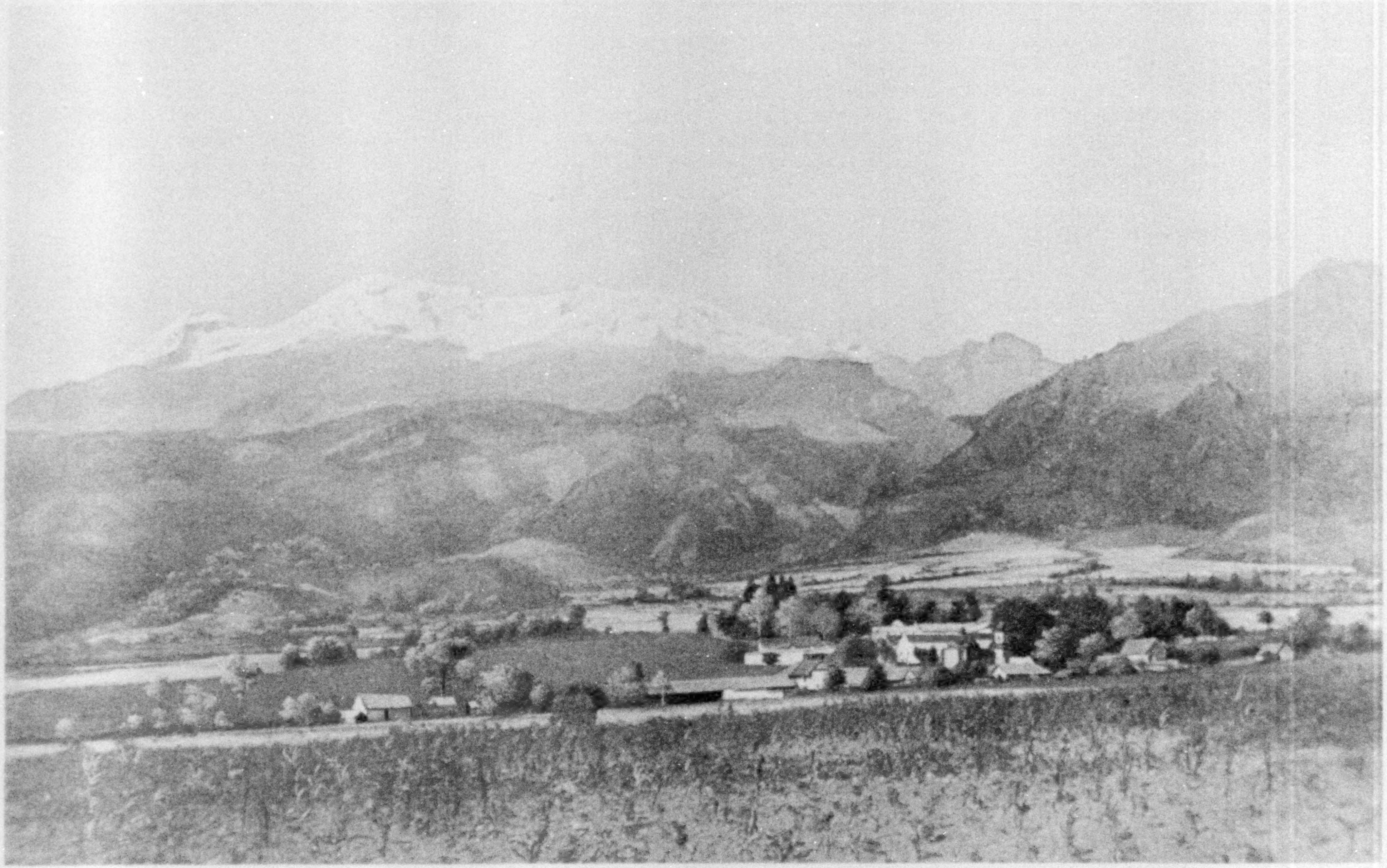


Photo from H. Ravell

IXTACCIHUATL AND THE SLEEPING WOMAN

The "man on the mountain" in the Catskills is matched by "the sleeping woman on the volcano" in Mexico. As seen from Tlalpan the hair of the sleeping woman seems to be streaming down the one end of the mountain.

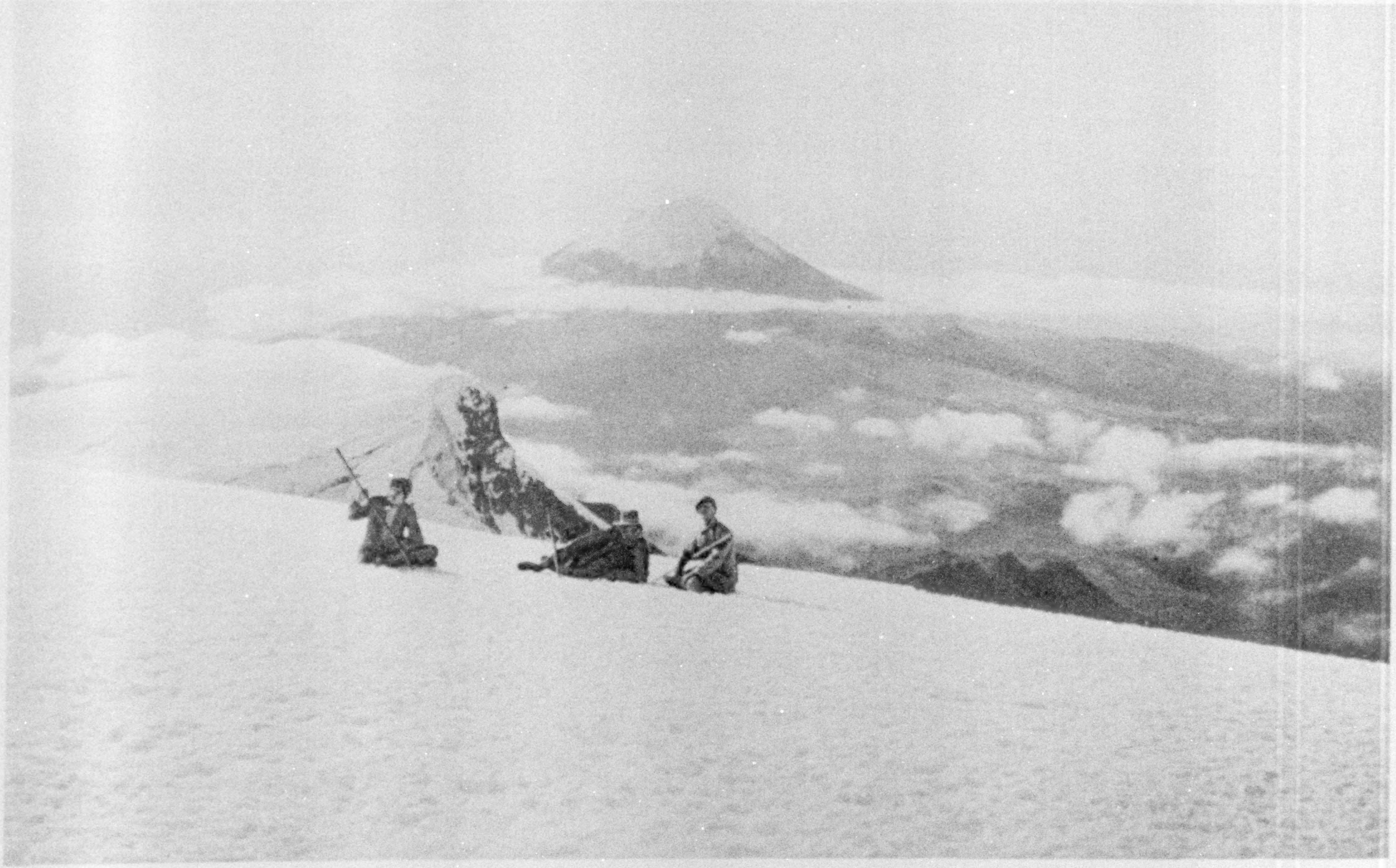
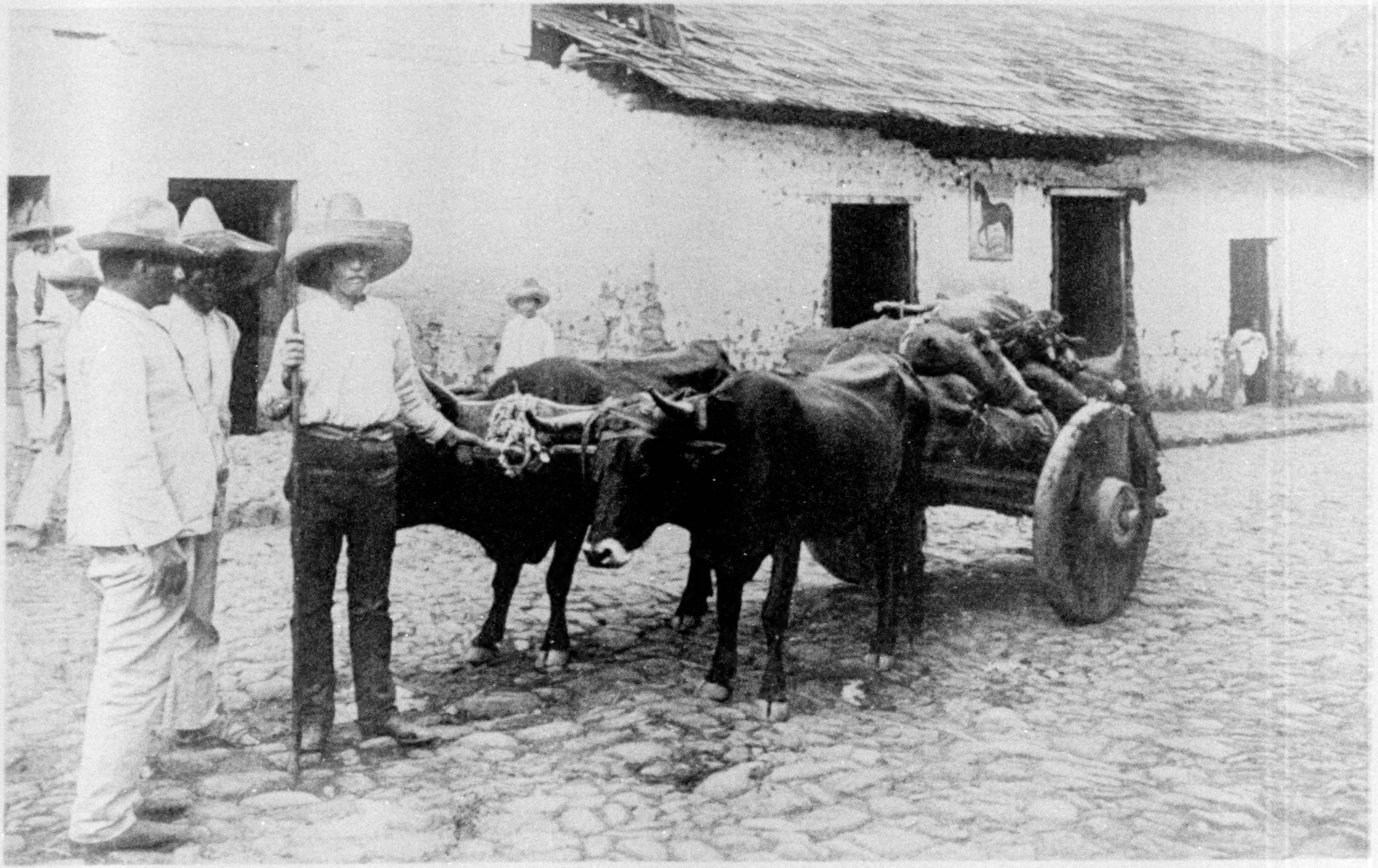


Photo from Alberto L. Godoy

THE SUMMIT OF IXTACCIHUATL

The two majestic volcanoes, Popocatepetl and Ixtaccihuatl, with their caps of perpetual snow, stir the heart of him who beholds them. From the summit of Ixta, 16,200 feet above the sea, one sees Popo, Orizaba, Xiantecatl and Matlacueyatl lifting their lofty cones above the clouds. Across the saddle between Popo and Ixta Cortez built the military road that led him to the capital of Montezuma.

XUM

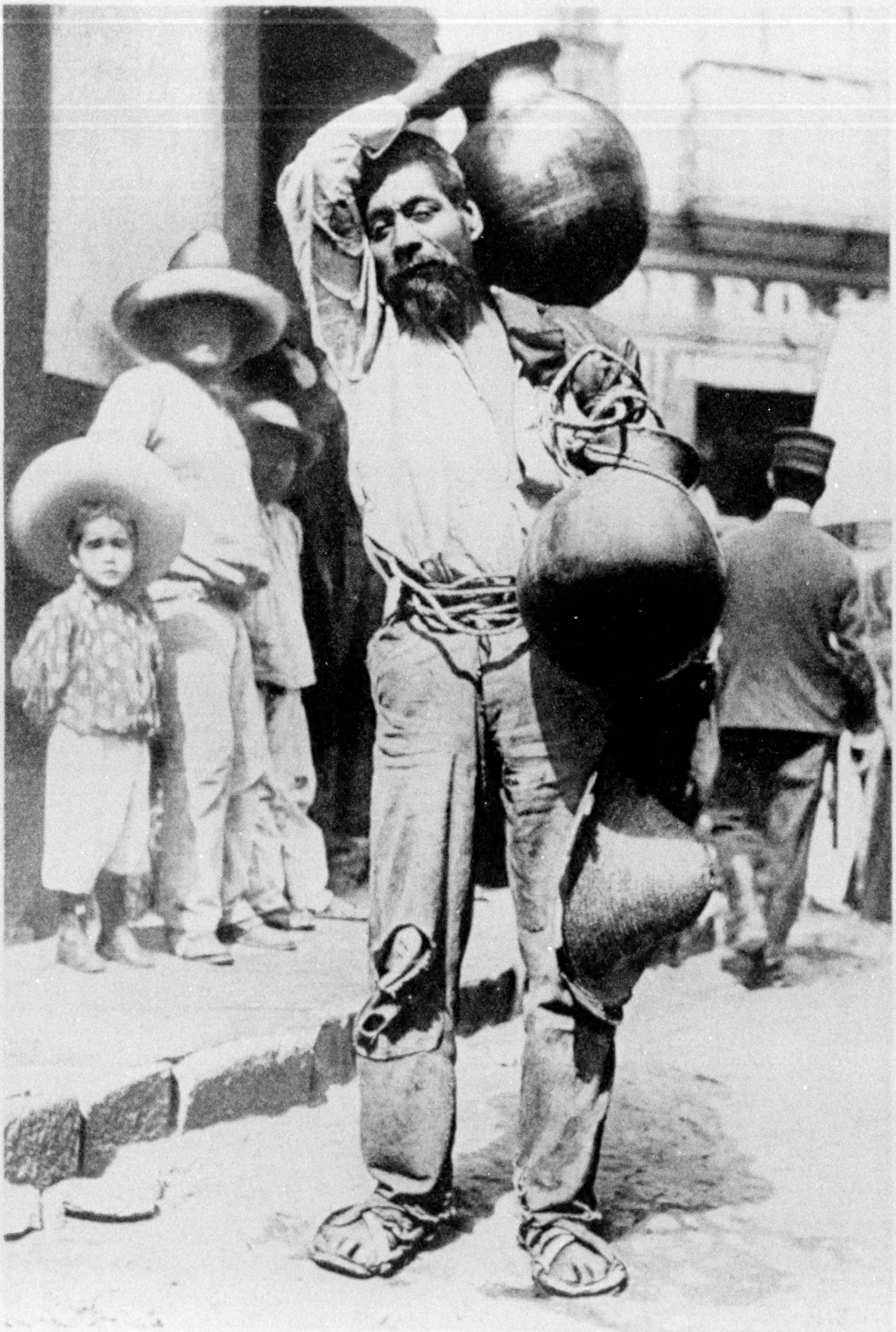


IN QUAINT URUAPAN, IN THE STATE OF MICHOACAN, MEXICO

Photo from Alberto L. Godoy

Where once the Indians of Uruapan fashioned the famous Uruapan lacquer ware, today the people are engaged in growing silkworms. Many of the sunny patios of the small houses are brilliant with the scarlet blossoms of the shepherd's flower. The Spaniards call the town "the paradise of Michoacan."

XUM

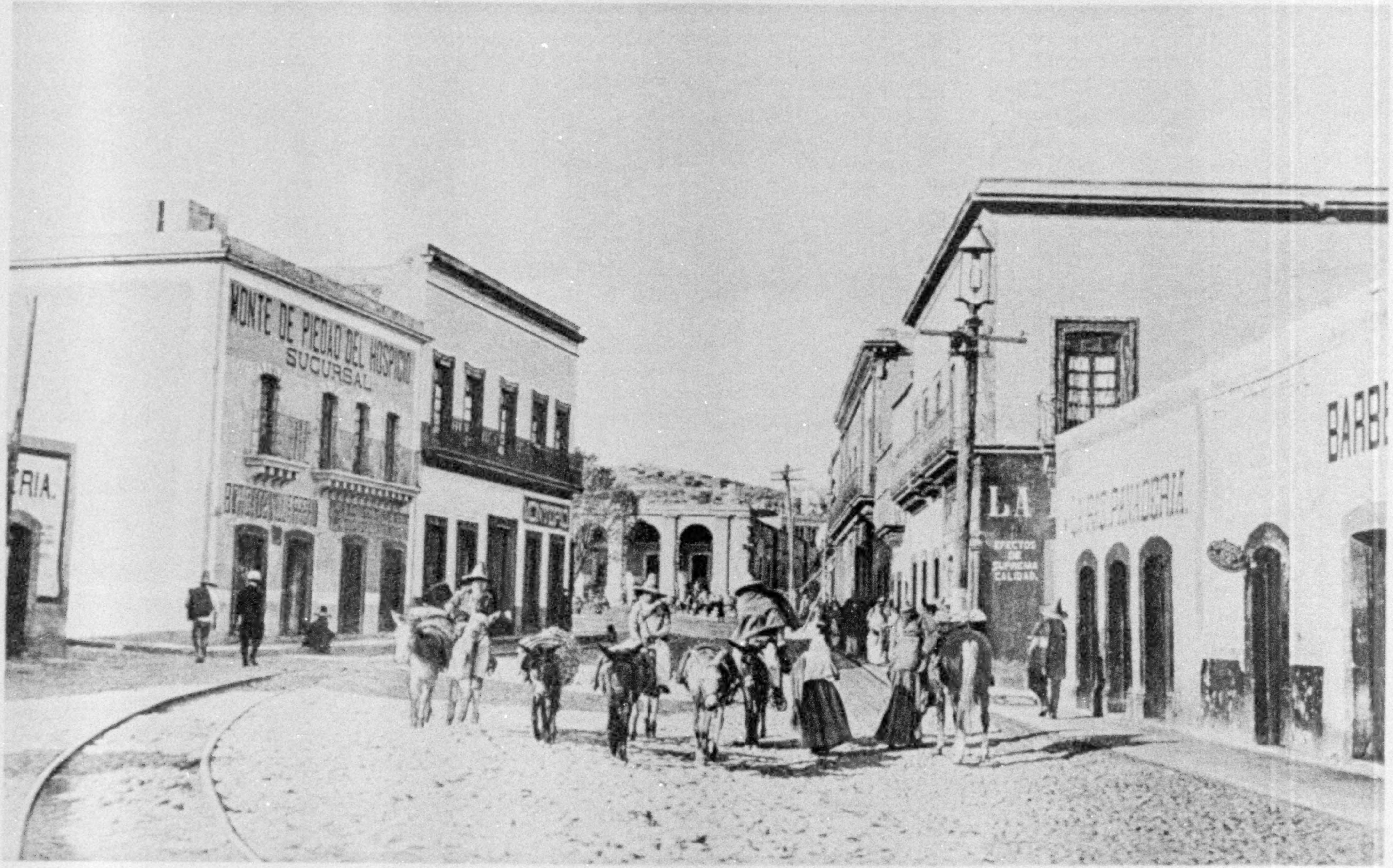


THE WATER CARRIER

Photo by John H. Hall

In every part of Mexico the water carrier flourishes. He gets the water from some spring or clear stream, and the people seem never to inquire about the presence of colon bacilli and only a few of them ever boil the water, which helps to account in a measure for the high death rate in Mexico.

XUM


MONTE DE PIEDAD DEL HOSPICIO
SUCURSAL
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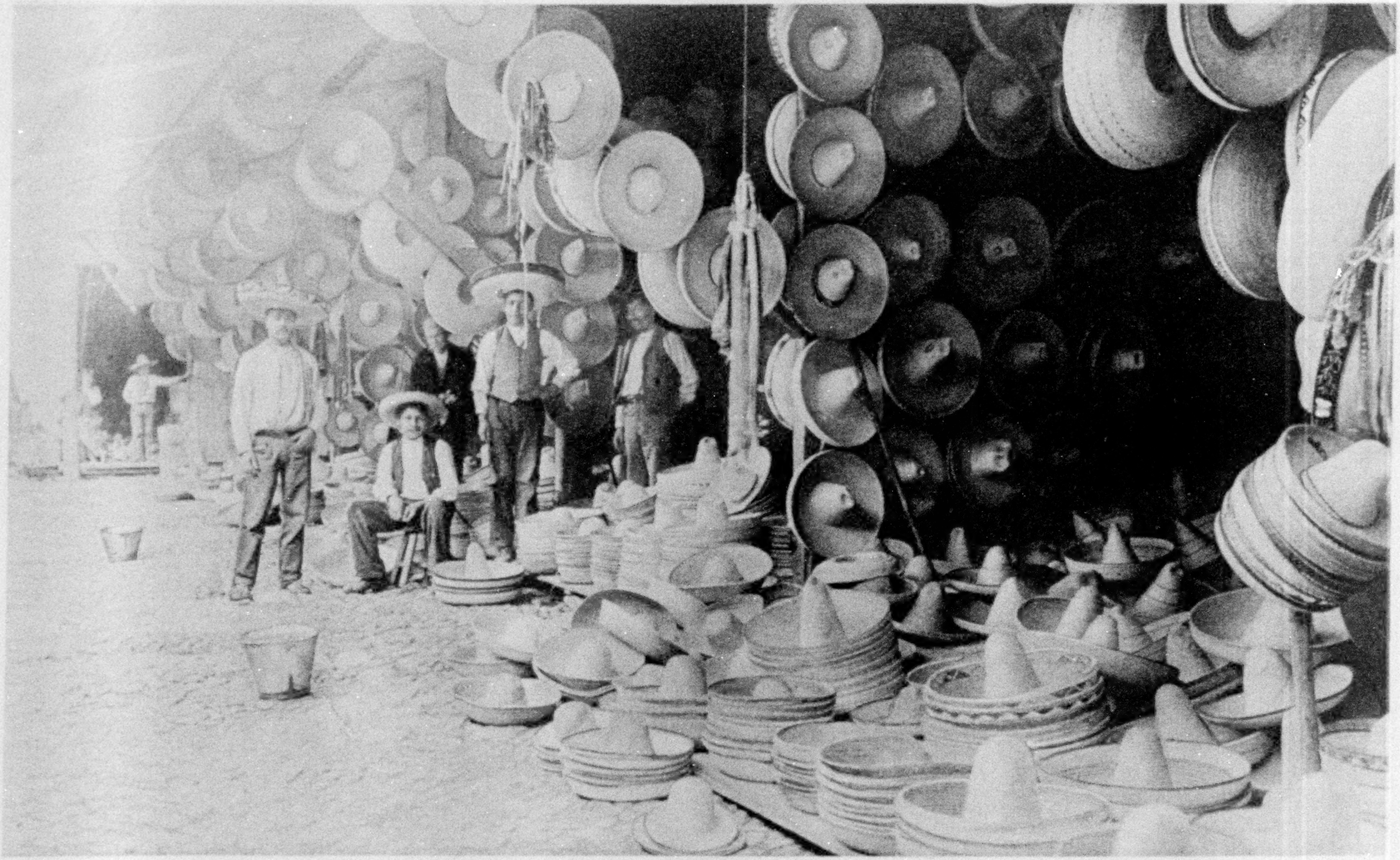
LA
EFECTOS DE SUPREMA CALIDAD
PANADERIA
BARBE

A TYPICAL STREET IN A TYPICAL TOWN

Photo from Carl Berenmann

Except in the larger cities of Mexico where the business quarter is the architectural handiwork of foreign interests, street scenes are distressingly similar. There seems to be no imagination in the mind of the Mexican architect.



A MEXICAN HAT STORE

Photo from Alberto L. Godoy

The lower class Mexican is fastidious about only one thing in the world—his hat. And the Mexican hat store carries a line that gives him plenty of room to exercise his fancy and to deplete his already slim pocketbook.

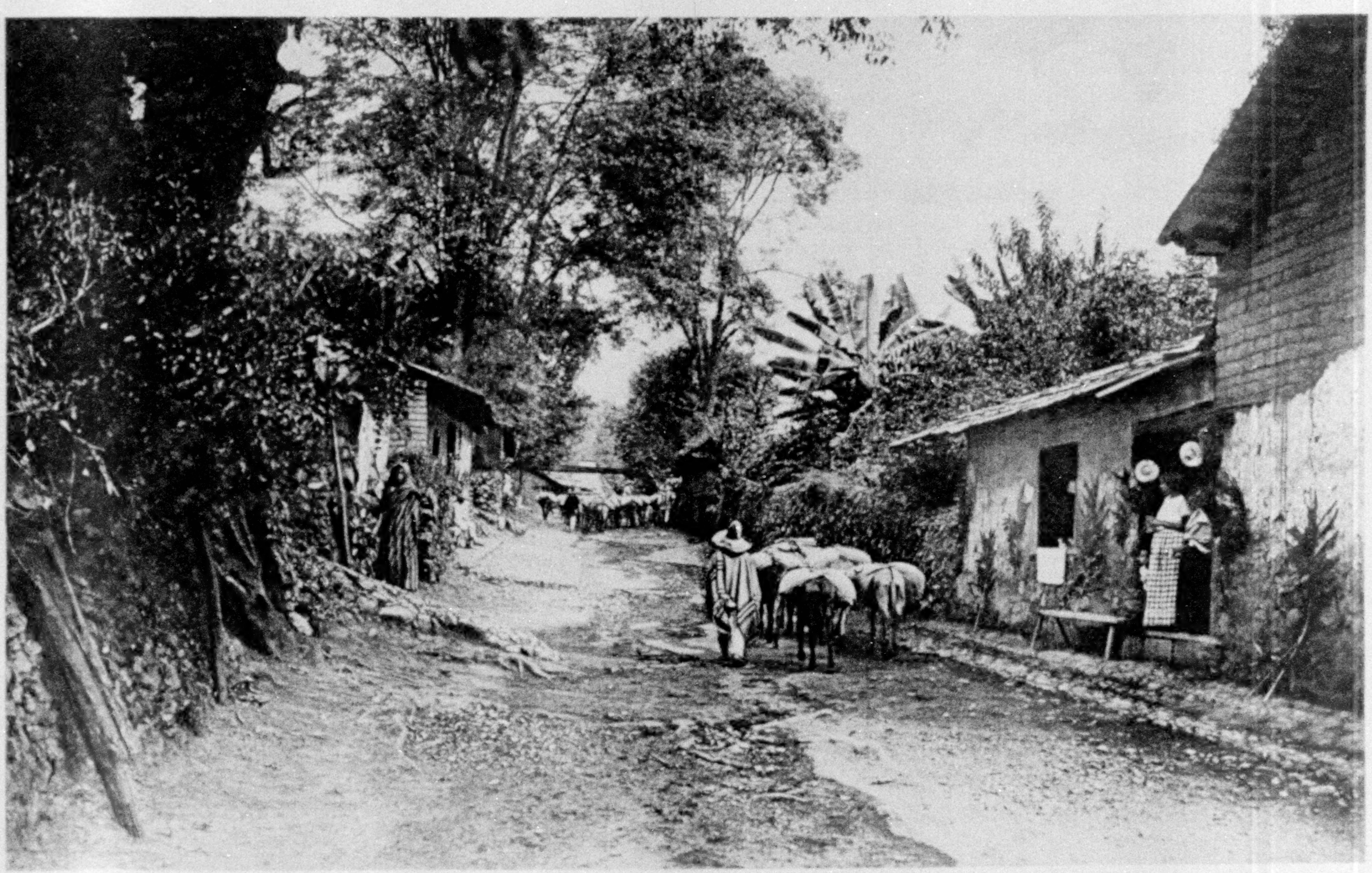


Photo from Alberto L. Godoy

A MEXICAN HIGHWAY

The people of Mexico do not go to any great trouble in building their country roads, and when they fence them they simply put cacti sprouts into the ground, and the fence grows.

XUM

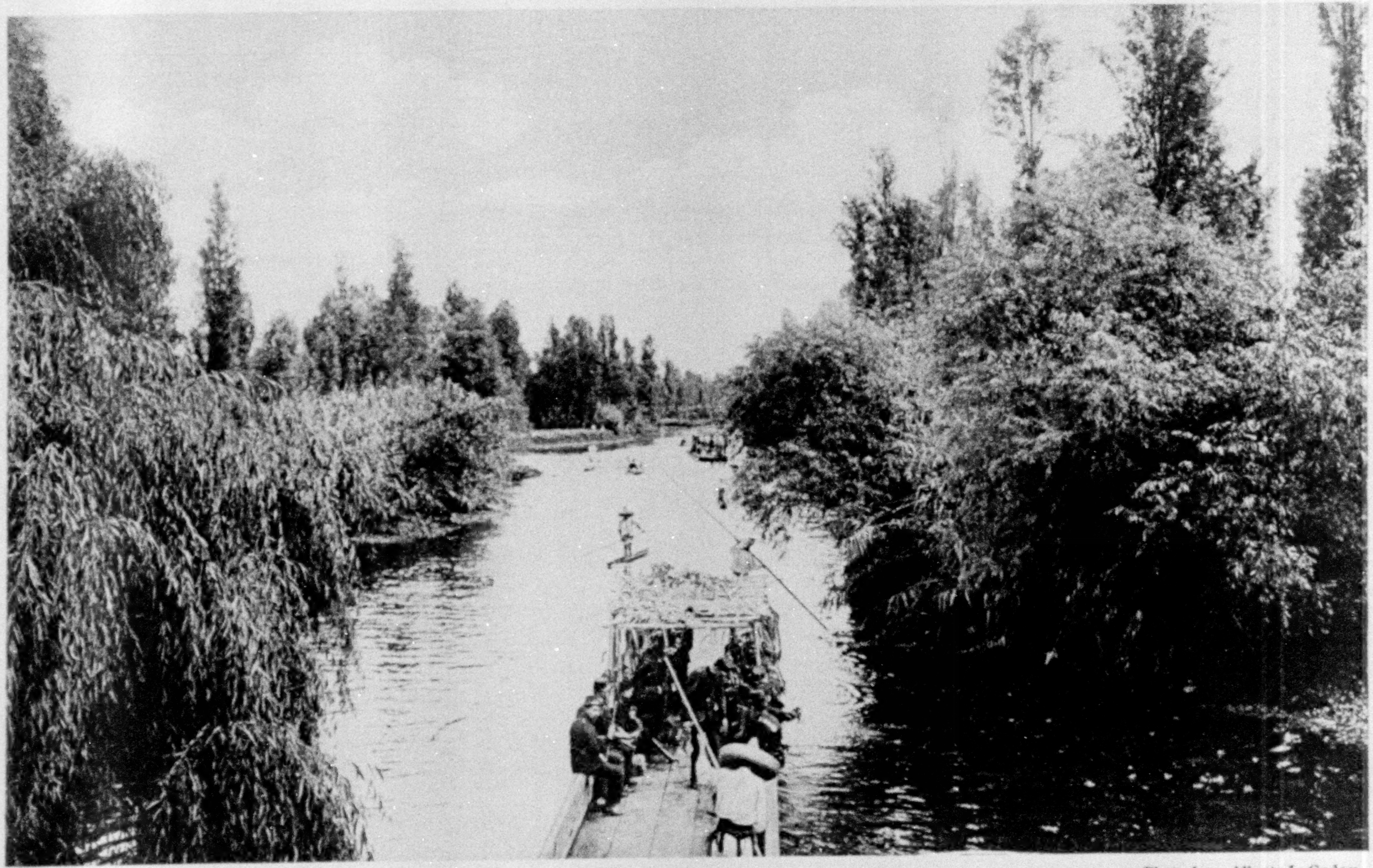


Photo from Alberto L. Godoy

SOLDIERS BEING TRANSPORTED ON XOCHIMILCO RIVER

The Mexican peon fights because he has to, but with all that, given good generalship and enough to eat, he makes a good soldier. "Volunteers" are usually brought to camp tied with ropes or handcuffed.

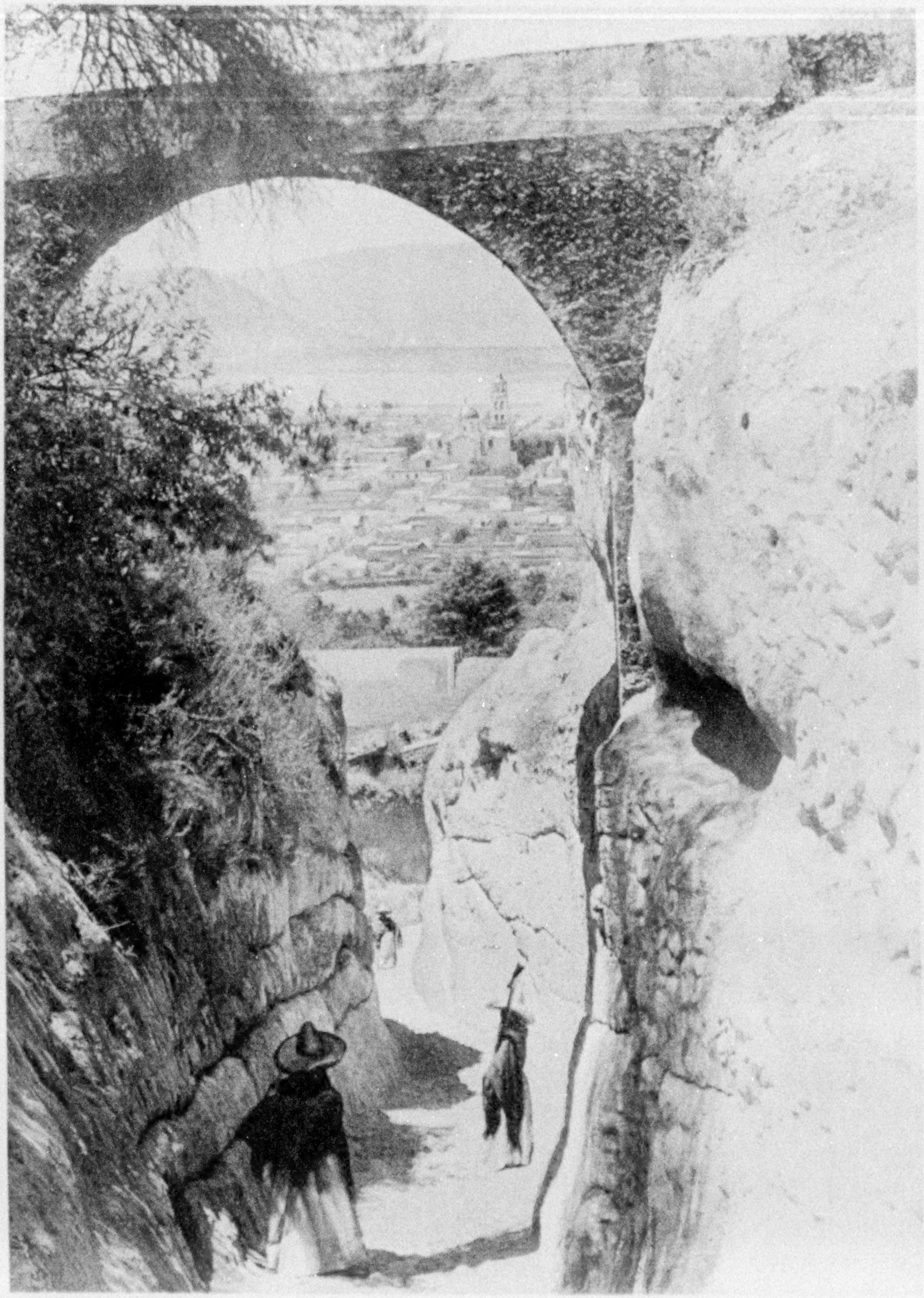


Photo from Alberto L. Godoy

THE SPAN OF AN AQUEDUCT

Most of the great mining centres of Mexico are located in the highlands where rain seldom falls and where the water supply must be brought for dozens of miles from the mountains.

XUM

DISCOVERY AND INVENTION*

BY ALEXANDER GRAHAM BELL

I AM going to begin tonight by asking you a rather startling question: Did you ever put your head under water and chuck two stones together to see what the sound is like? If you have never done that, try it, and you'll get a new sensation. I did it once, and it sounded as if a man were hammering for all he was worth at my very ear.

I then took two tiny little pebbles and tapped them together quite lightly under water, and it sounded like a man knocking at the door. It was rather startling to hear such a loud noise from such a slight cause.

Of course, the question at once arose in the mind: How far off could we hear the sound? So I sent a boy a hundred feet up the beach with a couple of stones, directing him to strike them together under water. I then submerged my head, and I could hear the sound about as readily as before.

Well, I determined to test the maximum possible distance, and sent the boy across the bay in a boat to the other side, to a point at least a mile away from the place where I stood, and I followed him with field glasses to see that he carried out my instructions. I saw him land on the other side, take off his coat, roll up his sleeves, and go down to a little plank wharf on the shore rising only a few inches out of water. He lay down upon the wharf, face downward, and put his hands into the water, and I then knew he was making signals with these stones.

Now, the question was: Could I hear him? Quietly and gently I went into the water at my side of the bay, submerged my head, and listened for all I was worth. Well, you know, the signals came perfectly clear and distinct, through more than a mile of water, to my ear. It was one of the most astonishing revelations of what could be done with water.

You know if you look away in the distance at a man firing a gun you can see the flash, and after a time you get the report: the sound takes time to travel through the air. It goes about 1,100 feet per second; but in the water it goes five times as fast as that—over 5,000 feet per second. Water is a much better conductor of sound than air.

DO FISH SIGNAL TO ONE ANOTHER BY SOUNDS?

Reflecting upon these various experiments, the thought occurred: If two little stones tapped together can be heard under water, why, every tiny lobster that snaps his claws must make an audible click. I wonder if there are creatures in the water that signal to one another by sound.

Well, I had occasion to try it once. Bathing in the Grand River in Ontario a great many years ago, I put my head very gently under water and listened, and, sure enough, "tick, tick," came a sound like a grasshopper's chirrup, and a little while after that a chirrup on the other side. There were creatures under the water that were calling to one another.

I don't know whether all fish make sounds or not, but there are some fish that certainly do. The drumfish on our coast drums away in the water so loudly that you can hear him while you are walking on the shore.

It is also a significant fact that all fish have ears. Why should they have ears if there is nothing for them to hear?

Of this we may be certain—that *there is a whole world of sound beneath the waves waiting to be explored*, perhaps by some of you.

I have wanted you to see how one observation leads to another. Starting with a very small thing—the chucking together of two pebbles under water, and following this up by other observations—we broaden our field of knowledge and reach generalizations of considerable magnitude as the resultant of numerous small thoughts brought together in the mind and carefully considered.

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*An address to the graduating class of the Friends' School, Washington, D. C., delivered May 22, 1914.

OUT OF THE BEATEN TRACK

I was walking along the road one day in my country place in Nova Scotia, when the idea occurred to leave the beaten track and dive into the woods. Well, I had not gone 50 feet before I came upon a gully, and down at the bottom was a beautiful little stream. I never knew of it before.

Of course, I was not satisfied with the mere discovery, but went down into the gully and explored it right and left. I followed it up to its source. I followed it downward for half a mile, through a beautiful moss-grown valley, until at last the little streamlet discharged into a pond, and away in the distance I could see a sea beach with the open water beyond.

Now, just think of that! Here was a beautiful gorge, half a mile long, right on my own place, and coming at one point within 50 feet of a well-trodden road, and I never knew of its existence before. We are all too much inclined, I think, to walk through life with our eyes shut. There are things all round us and right at our very feet that we have never seen, because we have never really looked.

Don't keep forever on the public road, going only where others have gone and following one after the other like a flock of sheep. Leave the beaten track occasionally and dive into the woods. Every time you do so you will be certain to find something that you have never seen before. Of course it will be a little thing, but do not ignore it. Follow it up, explore all round it; one discovery will lead to another, and before you know it you will have something worth thinking about to occupy your mind. All really big discoveries are the results of thought.

THE BEGINNINGS OF INVENTION

I dare say you have all heard of that celebrated painter who would never allow any one to mix his colors for him. He always insisted on doing that himself, and at last one of his students, whose curiosity had been aroused, said: "Professor, what do you mix your colors with?" "With brains, sir," said the professor. Now, that is what we have to do with our observations.

I think I left you with your head under water listening to the clicking of two stones. Now, let us see whether we cannot use our brains to get you out of so awkward a predicament. We will then have entered the realm of invention, as distinct from discovery.

Why should we not simply put the ear to the water instead of submerging the whole head?

Why should we not ring a bell under water instead of clicking stones together to make a noise. An ordinary dinner bell would do. Empty it of air and ring it under water, and the sound can be heard by a submerged ear at a great distance away.

It is a little awkward, however, to keep the ear continuously submerged on account of the movements of the surface water. Every now and then a little wave will slap you in the face, and you are apt to choke if you are caught unprepared.

Why would it not be better to transmit the sound vibrations from the water to the ear through some intervening mechanism, and thus obviate the necessity of submerging the ear at all?

I have tried submerged hearing tubes of various kinds and planks of wood partially submerged, with the ear applied to the part out of water.

If you put your ear to the bottom of a boat—inside, of course, not outside—you can hear a bell at a distance quite readily. It still is a little awkward, however, to get your ear against the planks of the boat; but brains will help you out. Just fix a telephone transmitter to the planks of the boat, and you can sit at ease with the telephone receiver at your ear.

You may even put the telephone transmitter overboard. It then becomes a submerged ear and will listen for you under water.

FISHING WITH TELEPHONES

I have often thought I should like to go on the banks of Newfoundland and fish with a telephone. If you were to send the transmitter down among the codfish with the bait, perhaps you would find something there to hear. I have never tried it. I will leave that to you.

We now have numbers of steamers

upon the Atlantic fitted with telephone transmitters attached to the thin iron skin of the hull, away down in the hold, and the receiving telephone on the bridge.

On shore there are huge bells at lighthouse stations making fog-signals under water, and each steamer as it approaches the coast can pick up these submarine sounds at a distance of 10 miles.

Here is a completed invention which some patient observer has evolved from just such little beginnings as those I have described.

I doubt whether you could hear a fog-signal through the air at any such distance as that. The air is at best but a poor conductor of sound, and many illusions of hearing are possible.

It is difficult in any case to tell the exact direction of a sound in a fog. It is possible, too, that you might have an echo from the sails of a vessel, and you would then be entirely misled as to the direction of the signal station.

Then, again, an island anywhere near casts a sound-shadow upon the water. The sound-wave striking the island is deflected up into the sky, and you would have to go up in a balloon to hear it, and it may not come down again to the surface for a mile or two beyond the island. A ship quite close to the island might not hear the sound. The captain, knowing that the fog-horn should be heard at least a mile or two away, imagines himself to be much farther off than he really is, and in the midst of the fog he may become conscious of the presence of the land only by actual contact with it.

Then the transmitting qualities of the air are subject to variations on account of unusual atmospheric conditions. You may be quite near a fog-signal station and yet hear the sound so faintly that you imagine it to be far away. You may even get an echo from the clouds; but then you know you are subject to an illusion, for the sound seems to come from the sky.

Now, sounds can be transmitted through the water to far greater distances than through the air, and atmospheric conditions have no effect.

I don't want to confine your attention to inventions that already have been made. I want to show you also that there is room for something new. We don't know everything yet and the list of possible inventions is not yet closed. Take, for example, the case we have been talking about, the transmission of sound through water.

EXPLORING UNDER THE SEA

Three-quarters of the earth's surface is under water and has not yet been explored, at least to any great degree. The only way we have of reaching the mountains and valleys at the bottom of the sea is by sending down a sounding line and bringing up a specimen of the bottom attached to the sinker. It is no joke, however, to reach the bottom of the deep, blue sea through one mile or even two miles of water, and it takes several hours to make a single sounding. Just think of all the time and labor involved in merely ascertaining the depth.

Why should we not send down a sound instead and listen for an echo from the bottom. Knowing the velocity of sound in water and the time taken for the echo to reach the ear, we should be able to ascertain the depth of the deepest part of the ocean in less than four seconds instead of more than four hours. Here is something worth doing. It has never been tried. I have suggested it a number of times, and I will now pass on the thought to you in the hope that some of you may care to take it up.

Suppose you are on one of those steamers provided with transmitter hulls and telephone ear-pieces, and you send down a little piece of gun-cotton or other explosive material to a safe distance below your ship and then explode it by an electrical contact. The sound-wave from the explosion will, of course, go down to the bottom and then be reflected up again, so that after a certain length of time you should get an echo from the bottom.

Not only should you be able to tell the depth of the ocean by an echo from the bottom, but you might perhaps learn something of the nature of the bottom itself. A flat bottom should yield a single sharp return, whereas an undulating bottom should yield a multiple echo, like that heard when you fire a pistol among hills.

Then, as you approach the shore you should get resonance effects, like those perceived when you shout out loudly in an empty cave.

However, I must not take up your time in speaking upon only one subject. What I want to direct your attention to is that both discovery and invention are not things that come all at once. They arise from very simple beginnings. A small observation, patiently followed up by other observations equally small, leads gradually to a big conclusion. Do not ignore little things; life itself is made up of them, and there is a good old Scotch saying that bears upon the point:

"Mony a mickle maks a muckle."

A great many small things make a big one. Any one, if he will only observe, can find some little thing he does not understand as a starter for an investigation.

AN EXPERIMENT AT HOME

I had rather a curious illustration of this the other day in my own house. I told a lad who was waiting upon me that I wanted to make some experiments with a bottle of water, and told him to bring a bottle of very hot water from the kitchen, and be sure that it was quite full. He soon returned with a big-bodied bottle provided with a long and narrow neck, filled to the brim, and put it on the mantelpiece and went downstairs. After the water had cooled, I rang the bell for John.

"John," I said, "I thought I told you to fill that bottle quite full."

"So I did, sir," he replied.

"Well, look at it now; it's not nearly full; the neck is quite empty."

John assured me that he had not touched the bottle since he first put it up, and I assured him that I had not poured any of the water out.

"Well," I said, "what has become of the water?"

He was quite nonplussed at first, and then he began to—to—ratiocinate, and said: "The water was quite hot when I put it in; there was steam coming from it. The water must have evaporated."

I made no comment, but looked at him and said: "Let's try it again. You fill that bottle chock full of hot water this time, and then *cork it* so that no steam can escape."

He did so; and by and by I rang the bell again, and up came John.

"John," I said, "I thought you filled that bottle quite full."

"So I did, sir," he replied.

"Well, look at it now; it's not nearly full." John assured me that he had not touched the cork, and I replied: "Well, what has become of the water?" John said he didn't know. He admitted that some of it had evidently gone, but where it had gone he couldn't for the life of him conceive, and he hasn't found out yet.

I am sorry now I didn't think of telling John to weigh the bottle when he first brought it up, for by weighing it again he could have found out exactly how much had disappeared.

If John hadn't given up he might have arrived by degrees at a realization of the principle upon which a thermometer works.

A thermometer is an instrument for measuring heat, and whenever you can measure a phenomenon you have a basis upon which may be built a science; in fact, all science is dependent upon measurement.

When you measure heat you get the science of thermo-dynamics, and thermo-this and thermo-that. When you measure the pressure of the atmosphere by a barometer you lay the basis for the science of meteorology and a whole lot of sciences dependent upon atmospheric measurements. So you have sciences based upon the measurement of sound and light; but you have no science of odor.

MEASURING AN ODOR

Did you ever try to measure a smell? Can you tell whether one smell is just twice as strong as another. Can you measure the difference between one kind of smell and another. It is very obvious that we have very many different kinds of smells, all the way from the odor of violets and roses up to asafetida. But until you can measure their likenesses and differences you can have no science of odor. If you are ambitious to found a new science, measure a smell.

What is an odor? Is it an emanation of material particles into the air, or is it a form of vibration like sound? If you can decide that, it might be the starting point for a new investigation. If it is an emanation, you might be able to weigh it; and if it is a vibration, you should be able to reflect it from a mirror. You can reflect sound and light and heat, and I have even warmed my hands at the reflection of a fire in a mirror. Not a glass mirror, for glass is opaque to radiant heat. A sheet of transparent glass makes a fine fire-screen. You can see the fire through it, but it cuts off the heat. When you try to reflect it from an ordinary looking-glass, the heat has to go through the glass in order to reach the reflecting surface behind and then pass through the glass a second time in order to get out. Take a sheet of polished metal—tin-foil will do—or any metal with a bright and shiny surface and you can reflect heat from it with ease.

Can you reflect a smell or measure its velocity of transmission? If you can do those things you will be well advanced on the road to the discovery of a new science.

THE SMELL OF TELLURIUM

Well, that reminds me of a discovery that started with a smell. We have a very rare elementary substance known as tellurium, and when you melt it with a blow-pipe it gives off a smell. We can't measure it, nor even describe it; but if you have ever smelled it you will know it ever after. There is nothing in heaven or on earth that smells like that.

Now, you know it is the object of many chemists and scientific men to turn their discoveries to some practical use. They try, through chemical and other means, to convert waste products, for example, into useful things. Indeed, the utilization of waste products is a characteristic of the age in which we live.

Just think what they have done. Here is a gas manufactory consuming coal. After the gas has been produced we have left upon our hands ashes and clinkers and a lot of evil-smelling tar. Well, the chemists go to work and out of that tar they make the most delightful perfumes for scenting handkerchiefs, and nice sweet essences for flavoring puddings, and the most beautifully colored dyes, all made from coal-tar.

Now, there was a distinguished chemist who thought he saw a chance of making something valuable out of the waste products obtained in the manufacture of sulphuric acid. Some of the powder he obtained he heated with a blow-pipe, and at once perceived the characteristic smell of tellurium. Here, he thought, was a rare and valuable element contained in a common and cheap by-product and it might pay to extract it. He then applied various chemical tests, but could get no other indication of the presence of tellurium excepting the smell. All the reactions declared there was no tellurium there.

He did not stop with this observation, but followed it up and began reasoning about it. If, he thought, there is no tellurium here, there is certainly something that has a smell very like it, and I know of no other substance on earth that has a smell like that. Perhaps there may be a new substance here, not yet discovered, which resembles tellurium, at least in the smell.

He knew that he was working with a regular conglomerate or mixture of all sorts of materials, many of which he could identify. He then extracted from the mass all the materials he knew were there to see if there was anything left; and, sure enough, a residue appeared which turned out to be, as he had suspected, a new elementary substance not heretofore known to man.

SELENIUM FOUND

He termed this substance *selenium* because it resembled tellurium. The word selenium, you know, is derived from a Greek word meaning the moon, and tellurium comes from the Latin—tellus, the earth. The two substances were not identical, but were related to one another as the moon is to the earth.

Selenium was found to resemble black sealing-wax in appearance. It had a beautiful, black, glossy surface, and in thin films was transparent, showing ruby red by transmitted light. In this, its vitreous form, it was a non-conductor of electricity, thus differing in a remarkable degree from tellurium, which was a good conductor.

When, however, selenium was heated almost to the fusing point and then allowed to cool very slowly, it completely changed its appearance. It acquired a dull metallic look, like lead; and in this, its crystalline condition, was also found to be a conductor of electricity, but of extremely high resistance. A little pencil of crystalline selenium not much more than an inch in length offered as much resistance to the passage of an electrical current as 96 millions of miles of wire, enough to reach from here to the sun, and yet it was a conductor. That was a discovery. Now comes an invention.

Willoughby Smith, in laying the Atlantic cable, found it advisable to balance the electrical resistance of the cable during the process of submersion by tremendous coils of well-insulated wire. Why, thought he, should not a little bit of selenium balance the whole cable and enable us to get rid of all this complication of wire.

He succeeded in doing this, but found the electrical resistance very variable. At times the selenium would balance the whole cable and at other times not one-half of it.

He did not stop with this observation, but sought the cause of the variation. He multiplied observations, and his assistant, Mr. May, soon discovered that the resistance of the selenium was greater at night than in the day.

This at once suggested to Willoughby Smith the thought that perhaps the electrical resistance of selenium was affected by light, and he proceeded to put his idea to the test of experiment. He shut up the selenium in a dark box near a bright light, and found that when the lid was open the resistance went down and when it was closed it rose again. Even a shadow falling upon the selenium affected its electrical resistance.

SPEECH FROM A SUNBEAM

Then other scientific men took the matter up. Professor Adams, of King's College, England, discovered that the resistance varied directly with the intensity of the light that fell upon the selenium. Then I came along with some speculations concerning the possibilities of telephoning without wires by varying the intensity of a beam of light by the action of the voice, and allowing the light to fall upon a piece of crystalline selenium. In this way I thought it would be possible to get speech from a sunbeam.

Well, I need not go into the details, but it was true. I produced the *photophone,* an instrument for talking along a beam of light instead of a telegraph wire. It is interesting to remember that all these things resulted from the observation of a smell.

When I was invited to talk to you tonight I had no idea of what to say. I thought of all the good maxims for your future conduct in life; but giving advice to young people is out of my line, and it seemed to be better to choose some subject with which I was a little familiar myself.

How discoveries and inventions arise from the observation of little things is surely a topic worthy of your consideration. I also thought it would be interesting for you to know how many apparently impossible results have been actually achieved by the patient multiplication of little observations.

It was only a short time ago that if you wished to express the idea that anything was utterly impossible you would say, "I could no more do that than I could fly." I don't think there is any one here who is too young to have heard that expression. It was the height of impossibility that we should fly, and here men are flying in the air today.

It is only a few years since the first man flew, and we are only at the beginning of aviation. What a delightful idea it is to go sailing through the air. The only trouble is that you must come down, and we have altogether too many fatalities connected with the work. Here, then, is a subject for you to explore: How to improve the safety of the flying machine. How to produce flying machines that any one can fly.

We know perfectly well that the time is coming, and is almost here, when it will be an every-day thing to go from place to place through the air. Perhaps some of you may find a field of occupation in bringing this about.

FLYING ACROSS THE ATLANTIC

Even today we have startling propositions to do things that are apparently impossible. A man proposes to try this summer to fly across the Atlantic Ocean in a heavier-than-air flying machine. The strange thing about the matter is that experts who have examined into the possibilities find that he really has a fighting chance.

You see the distance is less than 2,000 miles from Newfoundland to Ireland. This means that if you could go at 100 miles an hour you would cross the Atlantic in 20 hours—less than a day. Just think of that. Well, we have flying machines that go at a greater speed than that. We already have machines that could cross the ocean if their engines can keep going for 20 hours.

Of course, these are exceptional machines; but even the ordinary machines of today make 50 miles an hour with ease. Now, a flying machine flies faster as you go higher up, because the rarer air offers less resistance to the motion, while the propeller gives the same push with the same power, whatever the elevation. As you get into rarer air the propeller simply spins round faster.

A 50-mile-an-hour machine flying two miles high in the air—and we have machines that have gone twice as high as that—will fly much faster than 50 miles an hour.

Then at an elevation of two miles high in the air there is a constant wind blowing in the general direction of Europe having a velocity anywhere from 25 to 50 miles an hour.

As the net result of all these things, there can be little doubt that any ordinary machine that is able to support itself in the air at an elevation of two miles high will attain a speed of at least 100 miles an hour in the direction of Europe, and that means going from America to Europe in a single day.

Calculation shows that, taking all these circumstances into consideration, our best machines should be able to cross the Atlantic in 13 hours. I hardly dare to say it aloud for publication. It is sufficiently startling to know that it is not only possible, but probable, that the passage may be made in a single day. But if, as I imagine, it can be done in 13 hours, you may take an early breakfast in Newfoundland and a late dinner in Ireland the same night.

Now, I will not take up any more of your time. My idea has been to point out to you how great discoveries and inventions have originated from very little things, and to impress upon your minds the importance of observing closely every little thing you come across and of reasoning upon it.

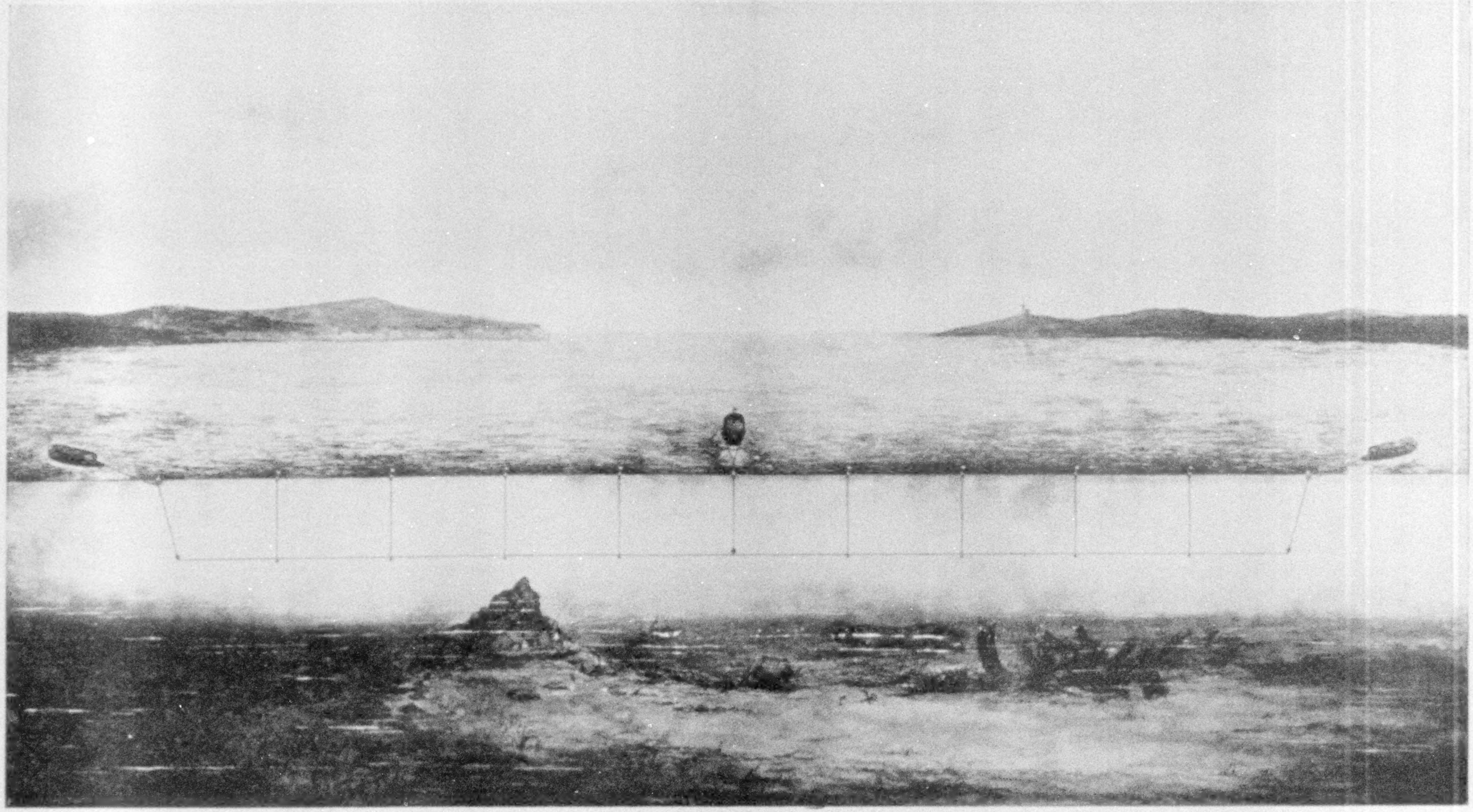
Indeed, as Smiles very happily puts it, "The close observation of little things is *the secret of success* in business, in art, in science, and in every pursuit in life."

OUR GUARDIANS ON THE DEEP

By William Joseph Showalter

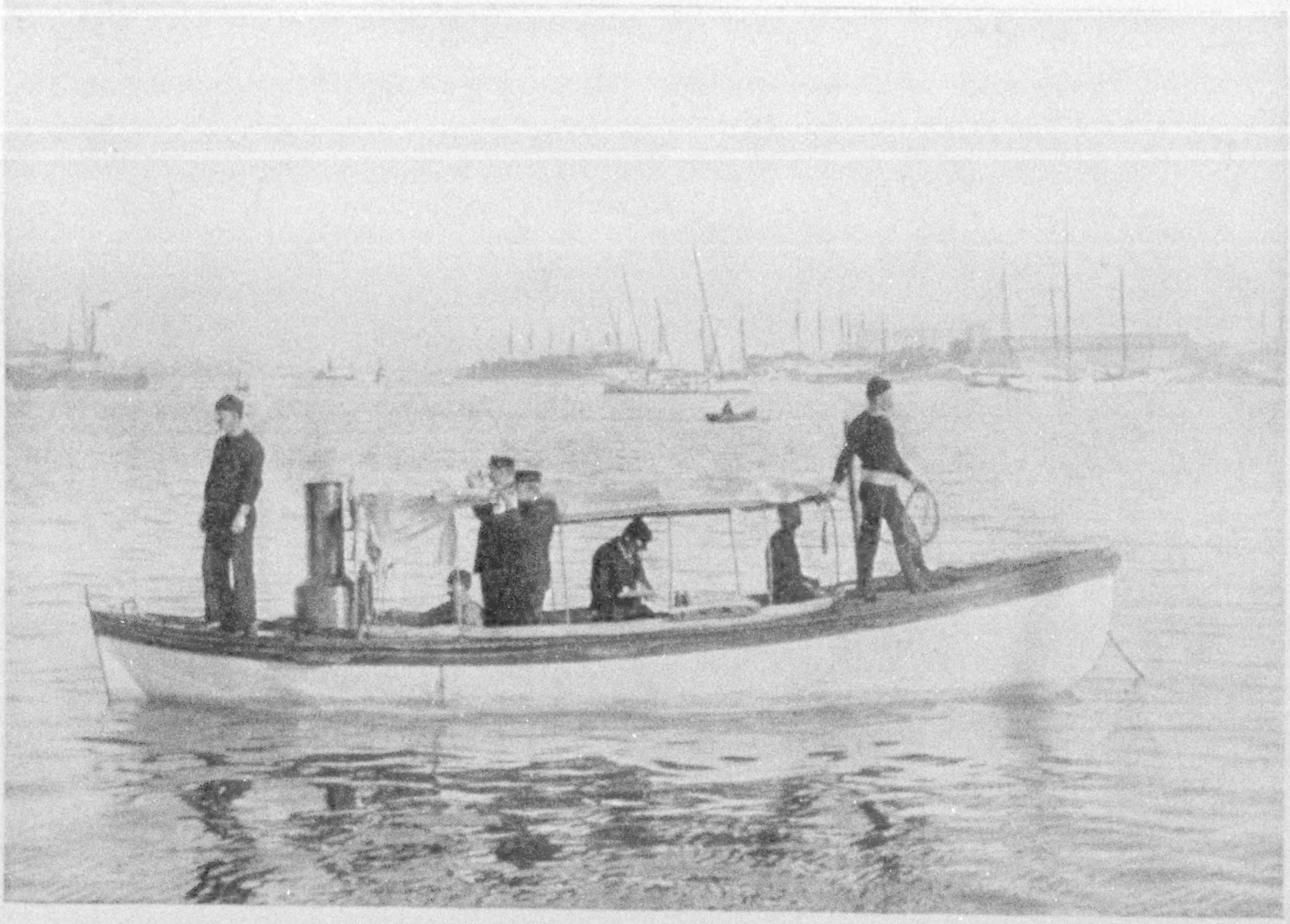
IN A very general way the people of the United States know that there is a government bureau in Washington called "The United States Coast and Geodetic Survey." Yet little indeed do they appreciate its many activities—activities which touch them, even though they are unconscious of the contact, almost every hour of every day of their lives.

Do they or their friends go down to the sea in ships, the Coast and Geodetic Survey stands between them and the perils of the deep, by furnishing the sailing directions that preserve those ships from harm. Do they live on lots that have been surveyed and on streets that have been laid out by a civil engineer, the Survey has contributed to the accuracy of the work. Do they drink water from city water mains, the fundamental



THE SWEEP WITH WHICH THE COAST SURVEY FINDS SUNKEN ROCKS

This is the most reliable apparatus yet devised for discovering the dangers to navigation that lurk beneath the surface of the sea. It is known as the wire sweep, and consists of a wire of any desired length, supported at intervals by buoys so arranged that the wire can be lowered to any given depth. The sweep is then attached to two or three small power-boats, depending on its length, and is towed slowly along. The wire catches upon any obstacle that it encounters. This obstacle is then further investigated by means of lead soundings. These wire sweeps vary in size from 100 feet to over a mile in length, and have been used to a depth of 45 feet (see page 660).



RUNNING A LINE OF SOUNDINGS (SEE PAGE 659)

This picture shows a sounding party in Baltimore harbor. The two observers are seen determining the position of the boat by sighting with their sextants upon beacons on the shore. In the bow the leadsman stands ready to cast the lead, while amidships is the recorder, all ready to note down the observations.

leveling work of the Survey enters into the consideration. In a hundred ways the work of the Coast and Geodetic Survey comes home to every one, and behind the curtain of its somewhat puzzling name it is engaging in a wide range of wonderfully interesting as well as useful activities.

WE HAVE 40,000 MILES OF SHORE-LINE TO BE CHARTED

In these days of great steamships and vast commerce it is necessary that minute information concerning our coastal waters be in the hands of navigators. A single sunken rock in the path of water traffic may send hundreds of souls to the bottom of the sea; a single point of shifting sands carried hither or thither by river or ocean current may ground a steamer; a single unplotted wreck on the bottom of a harbor may do millions of dollars' worth of damage.

For 96 years the work of charting our coasts and making safe the water roads along our shores and within our harbors has been going on. Rather a long task it has been; but then we have rather a long coast-line to survey. According to trend, it is 16,000 miles long; but when it is measured so as to include the shore-line of all large islands, bays, sounds, and estuaries within tidal range, it becomes upward of 40,000 miles long.

Furthermore, that coast-line is never the same. Its main features may be as fixed as the eternal hills, but many of its smaller features are as unstable as the shifting sands of the desert; and these affect every ship that sails its waters. Between 1835 and 1908 Rockaway Beach, near New York, grew to the westward at the rate of nearly 8 inches a day. In 73 years Coney Island's western end has shoved itself farther westward about 1,000 feet. When Vancouver explored Columbia River he found a single straight channel there. By 1851 Sand Island had appeared, creating a second channel. Since that time it has moved two miles in a northwesterly direction, and finally has closed up the northern channel.

OWING TO WINDS, TIDES, AND RIVERS, THE WORK IS NEVER COMPLETED

It is obvious therefore that the work of surveying our coast-line can never be finished, because the winds, the tides, and the rivers continually alter its minor details, thereby making new investigations necessary. These changes must be kept track of and charted and the mariners warned against them, else, confiding in the accuracy of the charts, they would literally be led into unsuspected traps. The location of all lighthouses, buoys, artificial and natural objects on the shore must be charted, and every other aid to navigation that will tell the skipper of any ship exactly "where he is at" and keep that information at hand all the time. Piers and deepened channels change the conformation of a harbor, and sand-bars rise up or disappear with considerable frequency. Without a proper notation of these things, navigation would be unsafe and insurance rates would be high.

Nor is this all. Marine architecture is progressing, and with that progress ships are growing longer, their waist-lines are getting broader, and their drafts are becoming deeper. In 1848 the loaded draft of the 20 largest ships in the world averaged 19 feet. In 1873 the average of the 20 largest ships was 24 feet, while even in 1898 the average of the 20 largest was only 29 feet. The length of the 20 largest ships in the world rose from an average of 390 feet in 1873 to 640 feet in 1903. It is obvious that a survey thorough enough to meet conditions in 1873 would be wholly insufficient to meet conditions in 1914.

Once a rock that was 25 feet below mean low water was of no interest to navigators; today three-fourths of our navy and half of our shipping would be in danger with such rocks uncharted. There are thousands of rocks dotting the under-water sections of our harbors and shore-lines that could be neglected 20 years ago, but which today are great menaces to navigation until they are located and marked on the sailing charts. For instance, the new super-dreadnought *New York* today would run aground in a thousand places along the Atlantic coast where the *Oregon* could navigate with impunity in the day when it was the crack ship of the American navy; thus the Coast and Geodetic Survey must always go deeper with its investigation of the bottom of navigable waters as the draft of ships increases.

A MARINER'S PICTURE-BOOK

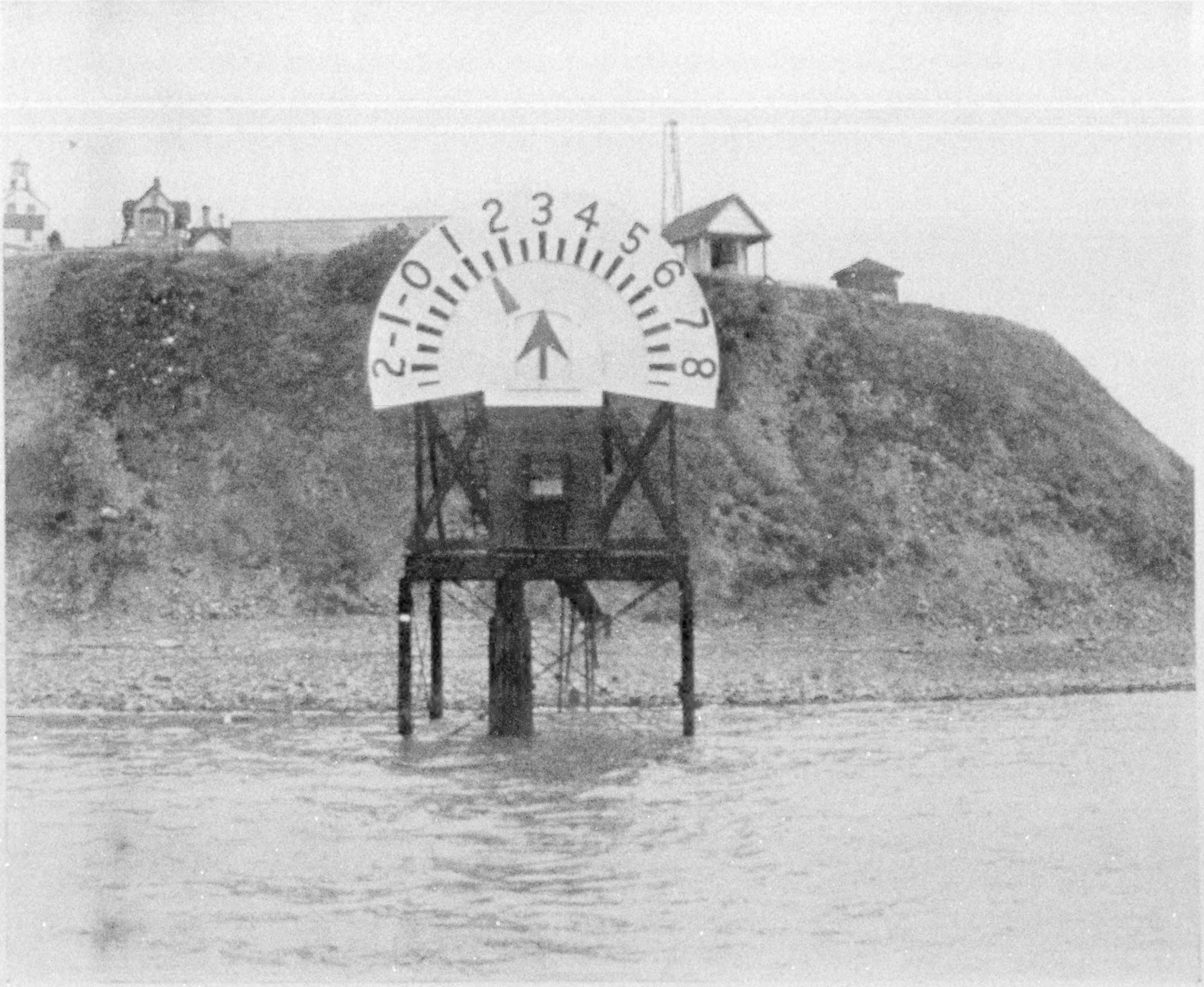
In short, the object of the coast survey is to make a series of map pictures by which navigators may read every detail of coastal or harbor conditions that will enable them to steer clear of all dangers. These pictures must carry to the eye of the mariner every feature of the shore-line, every important feature of the bottom over which his ship has occasion to pass, as well as that over which dangers forbid it to pass, and every detail of current, tide, and compass behavior that enables the mariner to keep in safe waters and out of dangerous channels.

On the map are located all the physical features of the neighborhood—its high-water line, its low-water line, its off-lying rocks, its streams, the elevations of its hills, its towns, roads, lighthouses, aids to navigation, church spires, tall chimneys, peculiar rocks and trees, and the like.

MAKING THE SOUNDINGS

In ascertaining the depth of the water and locating all the under-water obstructions to navigation, a careful record of the fluctuations of the tide while the soundings are being made must be kept. It would not suffice to measure the depth of the water if its height above mean low sea-level were unknown for the moment of measurement. To determine this a registering tide gauge is used—a sort of float attached to a mechanism in which a pen traces the rise and the fall of the water on a roll of paper which a clock causes to revolve under the pen.

Two methods of sounding are used, the one employing the lead line and the other the wire sweep. In lead-line soundings



AN AUTOMATIC TIDAL INDICATOR

This purely American aid to navigation automatically shows the height of the water at any moment. When the arrows point upward the tide is rising; when downward, it is falling. The index on the scale shows that at the moment when the photograph was taken there was an excess of 1½ feet above the normal level of the water.

the process is about as follows: A party goes out in a rowboat or launch, among its members being two observers with sextants and a map showing the shoreline and the objects whose positions have been determined by triangulation; a recorder with a clock and record book; a leadsman and a steersman. The officer in charge directs the recorder to make a note of the position of the boat, which is determined by the observers, and the leadsman casts his line and calls out the depth in feet or fathoms as he draws it up. The recorder makes a note of this and also of the course along which the boat is headed. At intervals of a minute or more the leadsman casts his lead, while every three or four minutes the observers take observations until the end of the course is reached, where a final set of observations locate the end of the line. The boat then turns and runs other lines in the same way, until the entire bottom of the surveyed area has been sounded (see page 657).

The resulting figures must be corrected so that they will all apply to what is known as "mean low water." This is fixed by taking the sum of the low-water readings for perhaps thirty days and finding their average. In fixing the depth of a sounding, the time the sounding was taken is noted and deductions or additions are made to conform with the state of the tide at that hour, as shown on the tide gauge sheets, so that all soundings are recorded on the chart as if made at "mean low water." On

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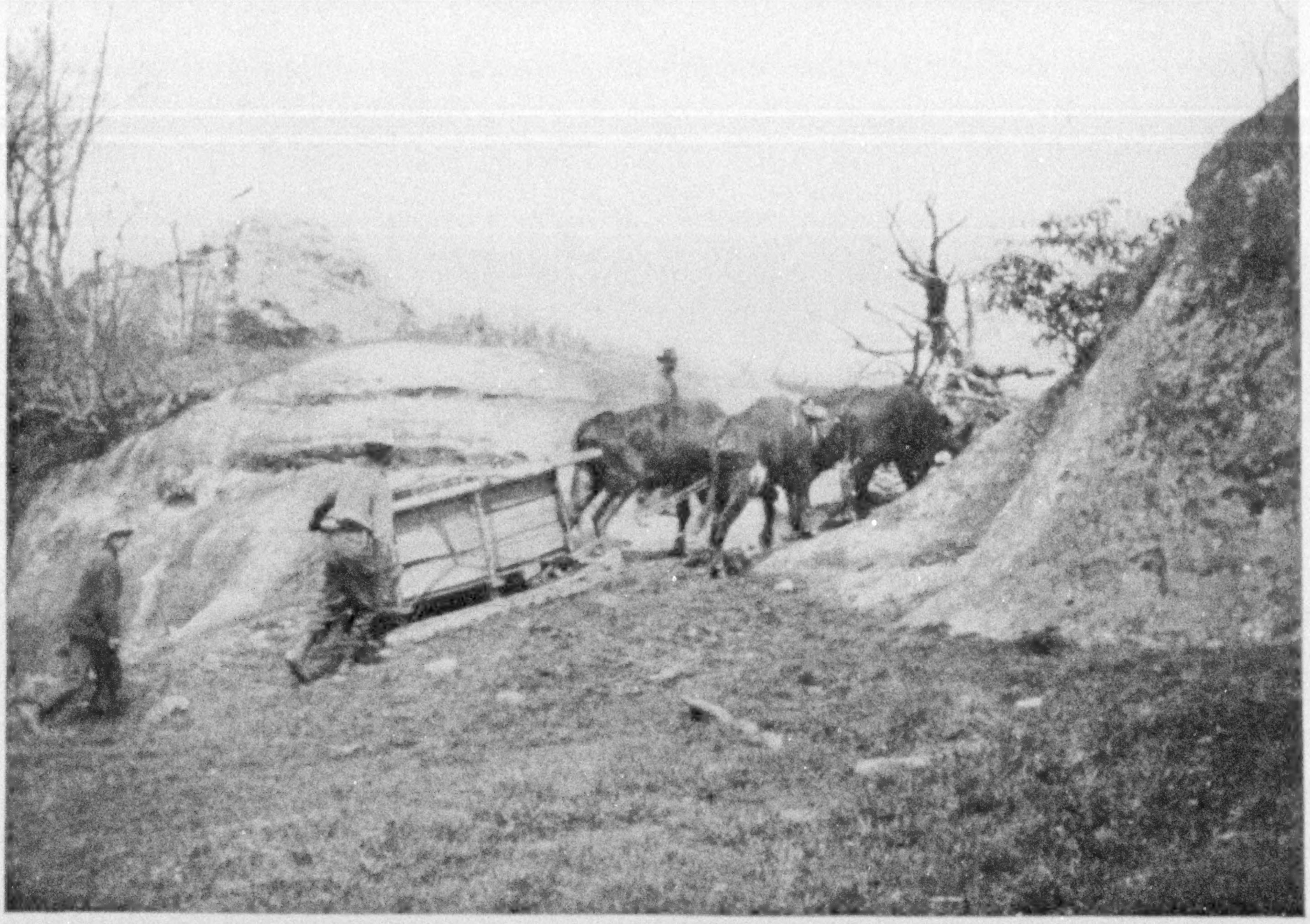


ONE OF THE JOYS OF SURVEYING

Using a sled and four bullocks to transport instruments to the triangulation station at White Rock, Virginia, which was situated in the mountains, miles from the railroad and approached by no road.

the Pacific coast, and in Hawaii, the Philippines, and Alaska the datum is lower, being "mean lower low water."

THE WIRE DRAG

The lead-line method of sounding suffices to record the lay of the bottom with sufficient accuracy where there are no extraordinary obstructions; but in a region like the coast of Maine and that of Alaska, where there are many isolated pinnacle rocks and ledges under water, or along shores like those of Florida, Porto Rico, and the Philippines, where coral reefs abound and coral heads fringe the coast, special investigations have to be made. The lead line might be cast all around a pinnacle rock—might even strike it a glancing blow—and still fail to discover it.

An instance of this kind occurred in Buzzard's Bay, Massachusetts, in 1902. Although more than 91,000 soundings had been made, more than 16,000 angles observed, and 1,462 miles of sounding lines run, a rock whose head was 18 feet below the surface was run upon by the cruiser *Brooklyn* during the naval maneuvers of that year.

In order to discover such obstructions in much frequented waters a new instrument, the wire drag, has been devised. It consists of a long wire, sometimes more than a mile long, weighted down at intervals with sinkers and supported at any desired depth by surface buoys. Several power-boats are hitched to it, usually one at each end and one in the middle, and with these it is drawn around a harbor much as a farmer drives his binder around his field of standing wheat. If it strikes no obstruction the hydrographers know that the harbor bottom is clear to the depth of the drag (see page 656).

Another line of information the mariner must have is about the movement of currents, so that his ship may not be

A PLANE-TABLE SURVEYOR MAPPING A SECTION OF SHORE-LINE

In making a survey of a harbor or section of shore-line, it is necessary to prepare a topographic map of the surrounding territory, showing all objects in the landscape that will help the navigator to fix his position (see page 658).

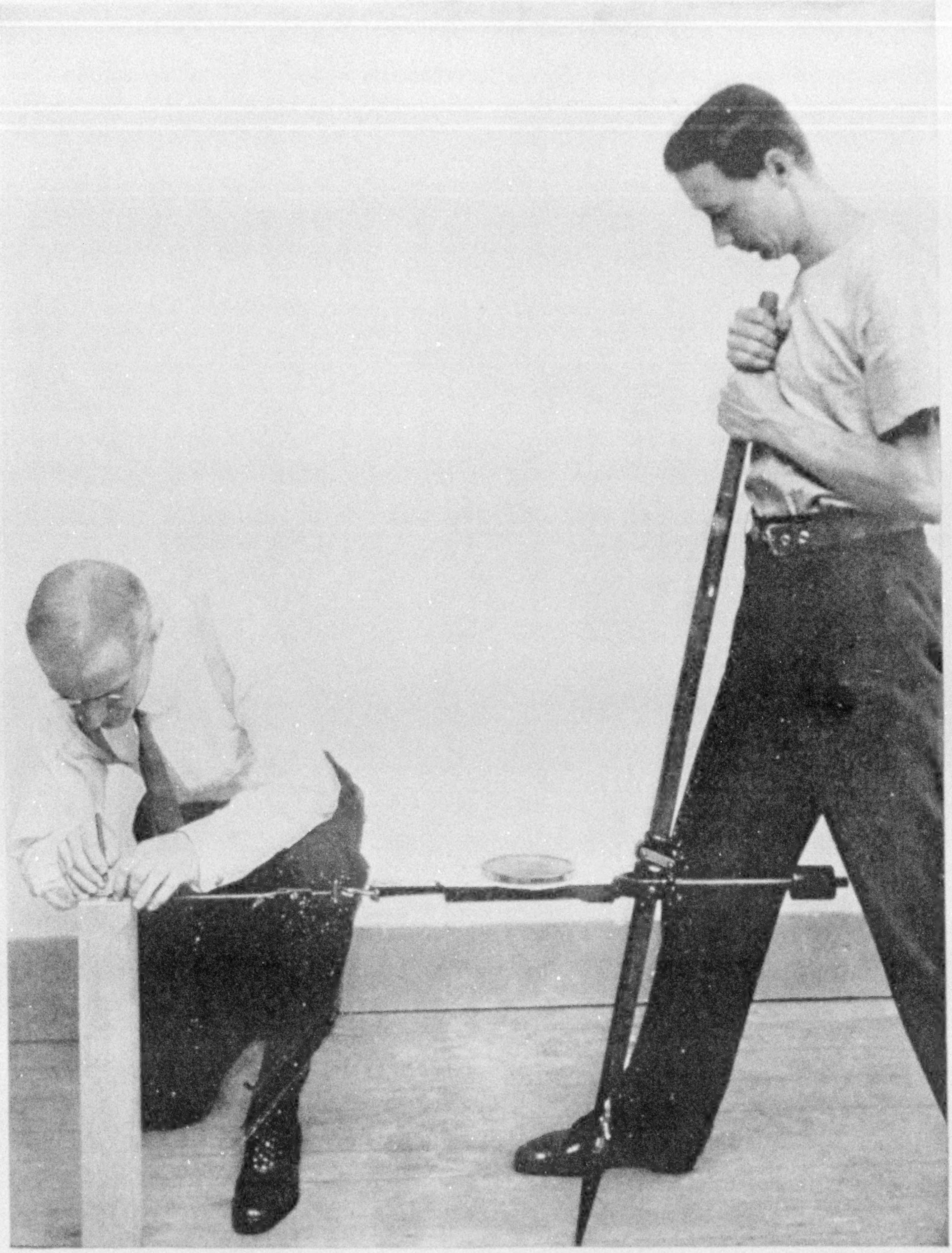
carried around by currents whose presence he does not suspect. Information concerning them is gathered by means of current rods, as a rule. A current rod is an instrument made to float vertically beneath the water, with only its tip showing above the surface, so that it is not disturbed by the wind. Its movement is observed, and the observations give definite information concerning the currents.

MAKING THE CHART

When all the work in the field has been finished, including observations which show the deflection of the magnetic needle, the force goes back to headquarters and begins the task of "writing up" its notes. And a bunch of notes they are to be written up! To make a single chart of a single harbor may require as many as 12 sheets of field hydrographic drawings, 16 sheets of field topographic drawings, 57 volumes of soundings, 22 volumes of tidal records, 20 volumes of trigonometric records, 7 volumes of altitude records, and 8 volumes of magnetic records.

Obviously the proposed chart cannot be as big as the area it is to represent, so the first thing to be determined is the scale to which it is to be drawn. In representing a harbor the usual scale is approximately half a foot to the mile, or exactly one foot to ten thousand feet. For ordinary navigation along the shore, where ships keep outside the 100-fathom line, a foot on the chart may represent nearly 80 miles, or, to be exact, 400,000 feet. On charts used to approach the coast the usual scale is about a foot to 16 miles, or one foot to 80,000, to be exact again. In all cases a foot on the chart represents just as great a distance on the land or on the water as a clear exposition of the facts to be placed on the chart will permit.

After the map is drawn it is reproduced either on copper plates or on aluminum plates. By photography a copy is made from the drawing, and this is laid down on the copper to fit the latitude and



MEASURING A BASE-LINE

In all Coast and Geodetic Survey work the accurately fixed and measured base-line is the foundation upon which everything else rests. It is measured by the use of invar tapes, which are almost wholly unaffected by heat or cold. The tape is stretched under a uniform tension, hence the spring balance in the picture. The marks for each tape-length are made in hardwood posts firmly set in the ground (see page 665).

longitude marks. The impression is then chemically fixed on the plate, and the engraver, who must have a high degree of skill and accuracy, proceeds to work. The figures showing the depth of the water at each point are put on the plates by a machine, one man being able to do with the machine the work of several by hand, cutting uniform figures and putting them in with mechanical accuracy.

Printing from copper plates is a laborious process. The ink is first placed on the plate and then wiped off with the palms of the hands of the operator and his assistant, leaving only a tiny bit adhering in the engraved lines. It is then run through the press, in contact with wetted paper, after which the prints are calendered by being subjected to a pressure of 600 tons in a hydraulic press.

For cheaper and more rapid work aluminum plates, coupled with the lithographic process, are used. A drawing is made on tracing vellum and then photographed on a sensitized glass plate. Positive plates are made from these negatives, and from these are transferred to the aluminum plates, which have been substituted for stones in the lithographic process. One of the old stones weighed 640 pounds and cost $185; the aluminum plates weigh 5 pounds and cost $4.50.

All the original information upon which every chart is made is filed away, and if one little detail were found wrong 10 years' later the very man who made the error could be located.

100,000 CHARTS ARE DISTRIBUTED EACH YEAR

The vast importance of the hydrographic work of the Coast and Geodetic Survey is illustrated by insurance rates in harbors where it has done its work and in those in which it has done nothing. In Nome, Alaska, for instance, the marine insurance rate is five-eighths of one per cent, the harbor being surveyed. At Kuskokwin, Alaska, the rate is from 1½ per cent to 5 per cent, with the agents not eager for business even at such rates.

The charts of the Survey are kept on sale at all times, and are sold at a price which covers only the cost of the paper and the actual printing. They are furnished to all the ships of the American navy, and the chart-room of one of the big superdreadnoughts contains a series of cabinets where the charts are always kept, ready for reference at a moment's notice. The Hydrographic Office furnishes the same kind of charts for foreign coasts that the Coast and Geodetic Survey furnishes for home coasts.

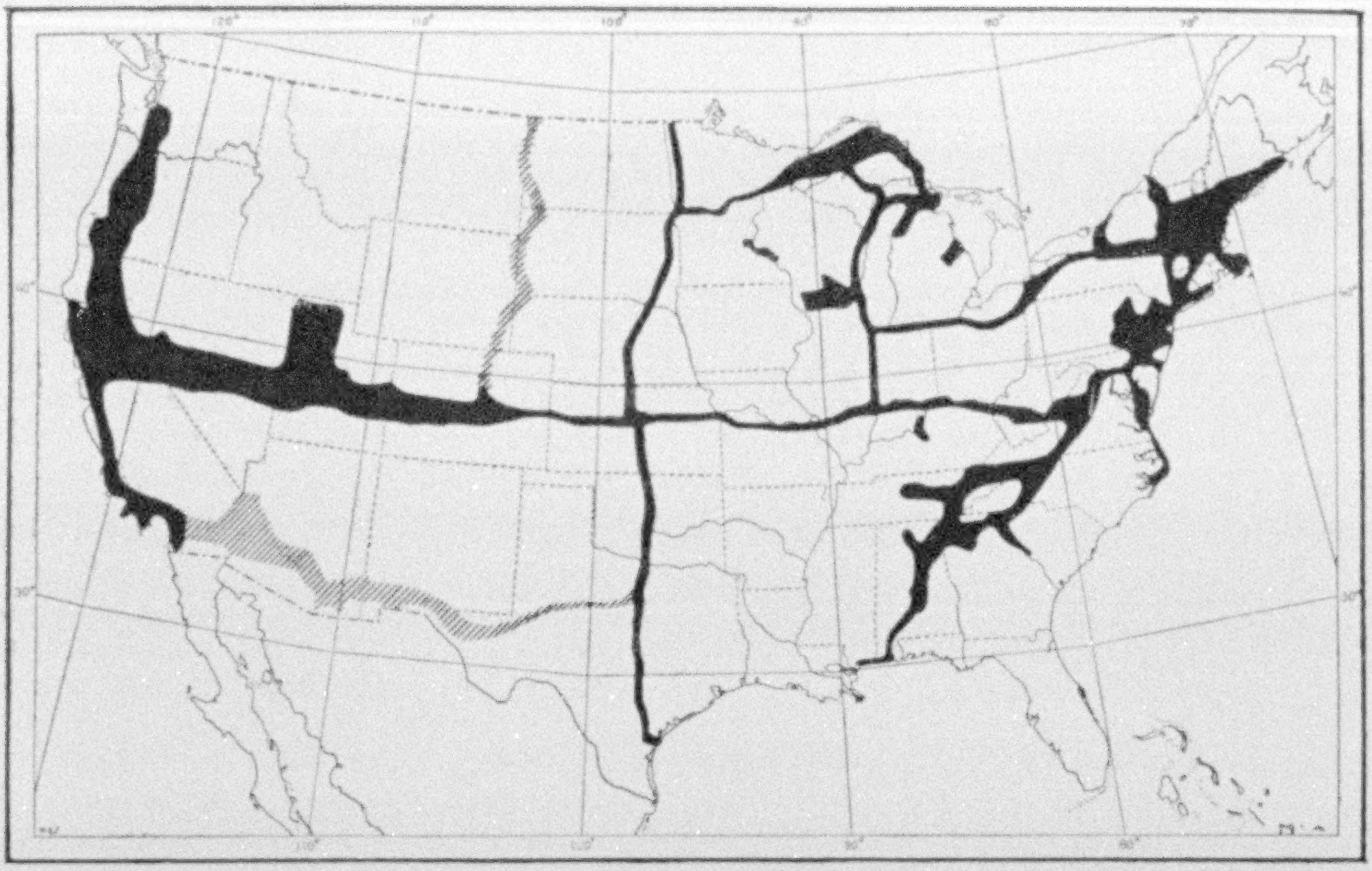
Nearly a thousand different charts have been prepared of the coasts of the United States and its outlying possessions since the Coast Survey was organized. These range in importance from the great charts of New York harbor, where billions of dollars worth of commerce and millions of lives are safeguarded every year, to the charts of places in Alaska, where a ship may not be seen more than once a week, or even once a month. The charts are in great demand by navigators at home and abroad, and the annual sale amounts to more than a hundred thousand copies.

ASTONISHING PRECISION

The geodetic work of the Coast and Geodetic Survey forms a fascinating part of its activities when one looks behind the mathematics involved. It deals with conditions that very many people do not know exist, and requires measurements of a refinement that must eliminate even the personal equation.

When work must be so accurate that it requires the elimination of the difference of the speed with which the eye telegraphs to the brain and the brain to the hand, in two men; when it must be so exact that a line a mile long may turn to the one hand or to the other no more than 1/33 of an inch; when it must reach that standard when the average error is less than one inch in 500 miles in leveling work, it is apparent that the most delicate instruments and the most refined measurements are required. Yet such is the standard set by the Coast and Geodetic Survey for its finest surveys.

It determines the longitude of a place by use of a transit instrument and the telegraph—the transit instrument showing to 1/500 of a second the exact moment at which certain stars cross the meridian of the place, and the telegraph



MAP SHOWING THE NETWORK OF PRIMARY TRIANGULATION IN THE UNITED STATES, ABOUT 10,000 LINEAR MILES BY THE COAST AND GEODETIC SURVEY AND ABOUT 2,000 MILES BY THE LAKE SURVEY

The Texas-California arc, indicated by shading in the lower left-hand portion of the illustration, and the one hundred and fourth meridian arc, similarly shown in the upper portion of the illustration, between the one hundredth and one hundred and tenth meridians, are the most recently completed of the larger arc. The former extends from central Texas to the Pacific coast, is 1,220 miles in length, covers an area of approximately 48,400 square miles, and determines the geographic positions of more than two hundred monumented stations and permanent objects. Connections were made with monuments of the international boundary between this country and Mexico and stations of detached triangulation by the United States Geological Survey.

Primary triangulation is necessary as a framework for coördinating and placing on a single basis all maps and charts made by the Federal and State governments. Monuments of a number of State boundaries are already connected with the triangulation net, and should they and all other evidence of the boundaries be destroyed, it is possible to replace them within a very few feet. It is planned to extend this triangulation until no place in the country is more than one or two hundred miles from a station. Intermediate areas will be controlled by triangulation of a lower order. In addition to the primary, there are many thousands of miles of secondary and tertiary triangulation along the coasts and inland, which furnish the immediate control of charts and maps (see also pages 663-665).

showing the time when they cross the meridian of a place of known longitude. A simple calculation, then, shows the difference of longitude of known and the unknown positions.

The latitude of a place is fixed also by observing the stars, when the Survey does its finest work. With a zenith telescope it notes the exact time when a pair of stars culminate, and after making allowances for refraction, temperature, and the like the determination becomes merely a mathematical one.

In making a survey, after the longitude and latitude of the starting point has been ascertained, a base-line is laid out. Its direction, with reference to the meridian of its starting point, is fixed with great accuracy; the line must not turn to the one side or to the other more than 1/33 of an inch to the mile. The instrument with which this determination is made is known as the theodolite, and consists of a small telescope mounted on a horizontal graduated circle. The lines on this circle are so finely engraved as to be invisible to the naked eye, and the operator reads each measurement by three different microscopes of high power, each of which must tell him identically the same story. Furthermore, he repeats this process of measuring and reading many times, so as to make sure he has avoided mistakes.

The length of the base-line is fixed as accurately as its direction, else all the work that follows would have no value of exactness. In the past these lines were measured with various kinds of apparatus, their accuracy being checked by comparison with a five-meter bar. This bar was a little more than five meters long, but the measuring part of it was the distance between two lines, invisible to the unaided eye, engraved upon iridium plugs inset in its surface. While in use, the bar was kept at a constant temperature by melting ice packed around it. The trough supporting the bar was mounted on a carriage moving upon a track built for the purpose. The successive positions of the ends of the bar were determined by high-powered microscopes firmly attached to heavy posts solidly planted in the ground.

This method, slow and expensive, even when used to check the work of simpler apparatus, has in late years given place to the invar-tape method. Invar tapes are made of an alloy of nickel and steel, and their lengths are practically exempt from the influences of heat and cold. They are used in connection with spring balances, which determine the amount of tension on the tape at the moment of measurement. This method is as cheap as it is accurate and permits much more frequent base-lines, and therefore there is less liability to error (see page 662).

DIFFICULTIES OF THE WORK

The position of the starting point determined, the length and direction of the base-line measured, the distances between hundreds of other points are fixed by triangulation. The surveyors take one line of known length, and from its two ends observe two other directions to a common meeting point, thus making a triangle. By measuring the angles of the triangle they can determine the distance between the two ends of the base line and the third point more rapidly than if they had taken a standard meter-bar packed in melting ice and laboriously measured the entire distance up hill and down dale, across river and over mountain peak.

In some of the triangulation in mountainous country the lines joining adjacent stations are frequently as much as a hundred miles long, and for such distances special signals have been devised. In daylight observations are made on the heliotrope, a reflecting mirror which reflects the rays of the sun to great distances. The most satisfactory signal, however, is a high-powered automobile headlight used at night. Some of these lamps in the atmosphere of Arizona have shown distinctly through the telescope of the theodolite over a distance of 120 miles (see page 669).

In triangulation work high mountains are desirable, as they more than atone for the difficulty involved in scaling them by the great area of country they spread before the observer. When work is done on level or nearly level ground or in heavily wooded country, it is necessary

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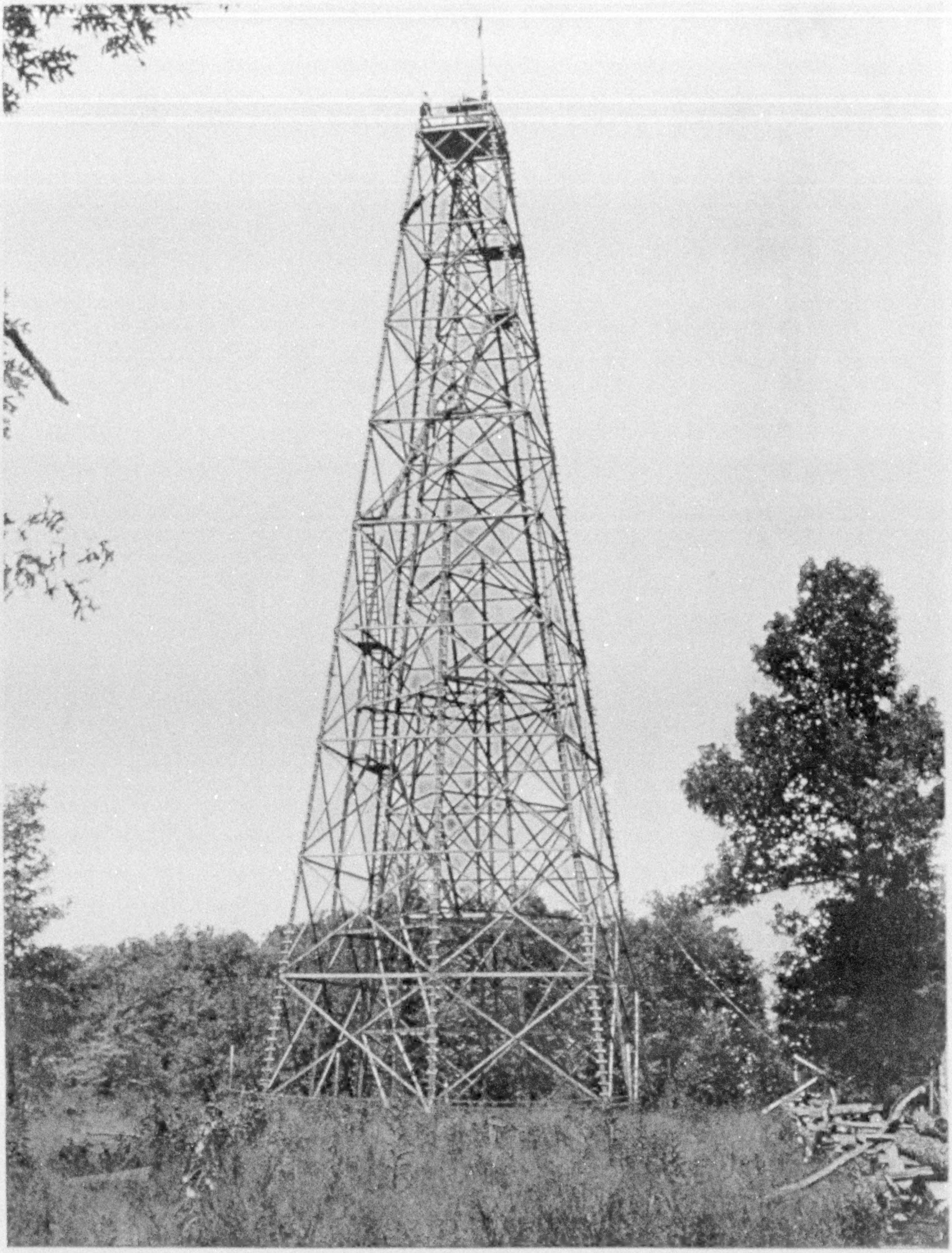


A TRIANGULATION STATION

When doing triangulation work in a level or wooded country, it is sometimes necessary to build a high tower that will bring the observers above the trees and buildings of the neighborhood and afford them an unobstructed view of other towers or natural objects in the distant landscape. On the coast of Washington a crow's-nest was built on a tree-top and an elevation of 215 feet was secured.

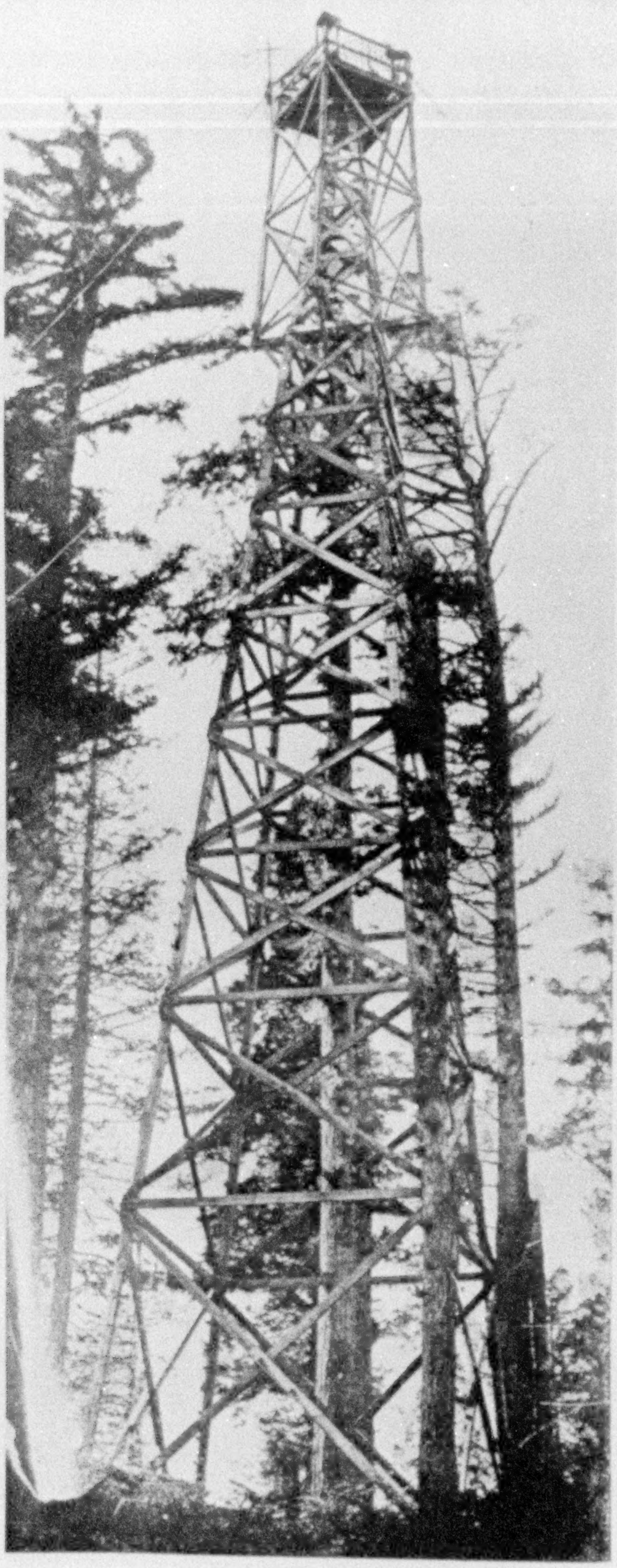
to build high towers if the distance be long and to overtop the trees if they interfere. In a perfectly level country, with a line of 20 miles, the towers must be 60 feet high to overcome the curvature of the earth and to make the line clear between the light and the theodolite.

THE GREAT ARCS OF TRIANGULATION

The progress of the Coast and Geodetic Survey is graphically shown in the map on page 664, which reveals the fact that a band of triangulation has been stretched from the frontier of Maine along the coast to the mouth of the Rio Grande. Here a line has been run due north to the Canadian border, where it intersects with the boundary between North Dakota and Minnesota. From this arc, at a point not far west of Fort Worth, a line swings westward to the California coast and thence to Puget Sound, and thence along the Canadian boundary to the line extending north from the mouth of the Rio Grande.

Another great line cuts across the country from San Francisco due east to the Blue Ridge and Allegheny Mountains, where it intersects another line running from the Maryland line to Mobile, Alabama. This latter line has a greatly extended area in the vicinity of the approximate juncture of the boundaries of Tennessee, North Carolina, Alabama, and Georgia. A short line has also been run across the northern neck of Florida, one up the Mississippi, one from a point south of Denver to the Canadian line, and one from the North Dakota-South Dakota-Minnesota intersection to the western shore of Lake Superior.

In addition to these, there are a number of disconnected surveys here and there over the country and a number of reconnaissances or preliminary surveys. Upon these lines of triangulation are based all the exact knowledge we have concerning the exact location of surface of the United States as a geographic entity.



THE GREAT CASPAR SIGNAL

When surveying in Mendocino County, California, a signal tower was built round a great tree, the trunk of which was used to support the top of the tower, and in this way the instruments were elevated to the height of 135 feet above the ground.

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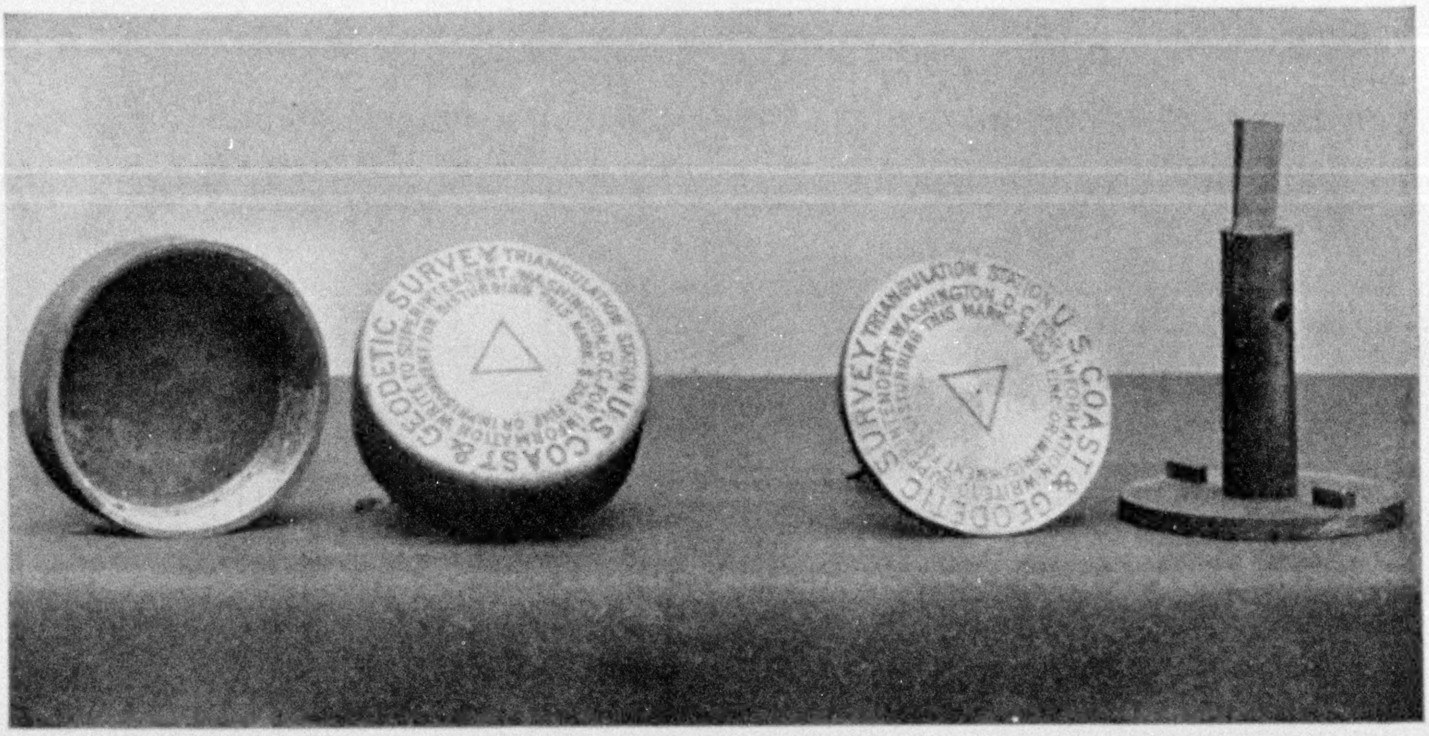


THE METAL DISCS WITH WHICH THE COAST AND GEODETIC SURVEY MARKS ITS TRIANGULATION STATIONS

Each triangulation is marked by brass and iron discs as shown in the picture. These marks are useful not only to members of the Survey who desire to relocate positions, but also to private surveyors who desire to connect their survey with one of these control points.

Every survey must have a beginning, and the beginning point of the great national triangulation survey is a point in Kansas formerly known as the United States Datum, but now as the North American Datum. All surveyors' lines in the United States eventually will lead from here, as all roads led to Rome in a bygone civilization. Canada and Mexico have adopted the North American Datum, so that practically the whole of North America which has been connected trigonometrically is hitched to this point.

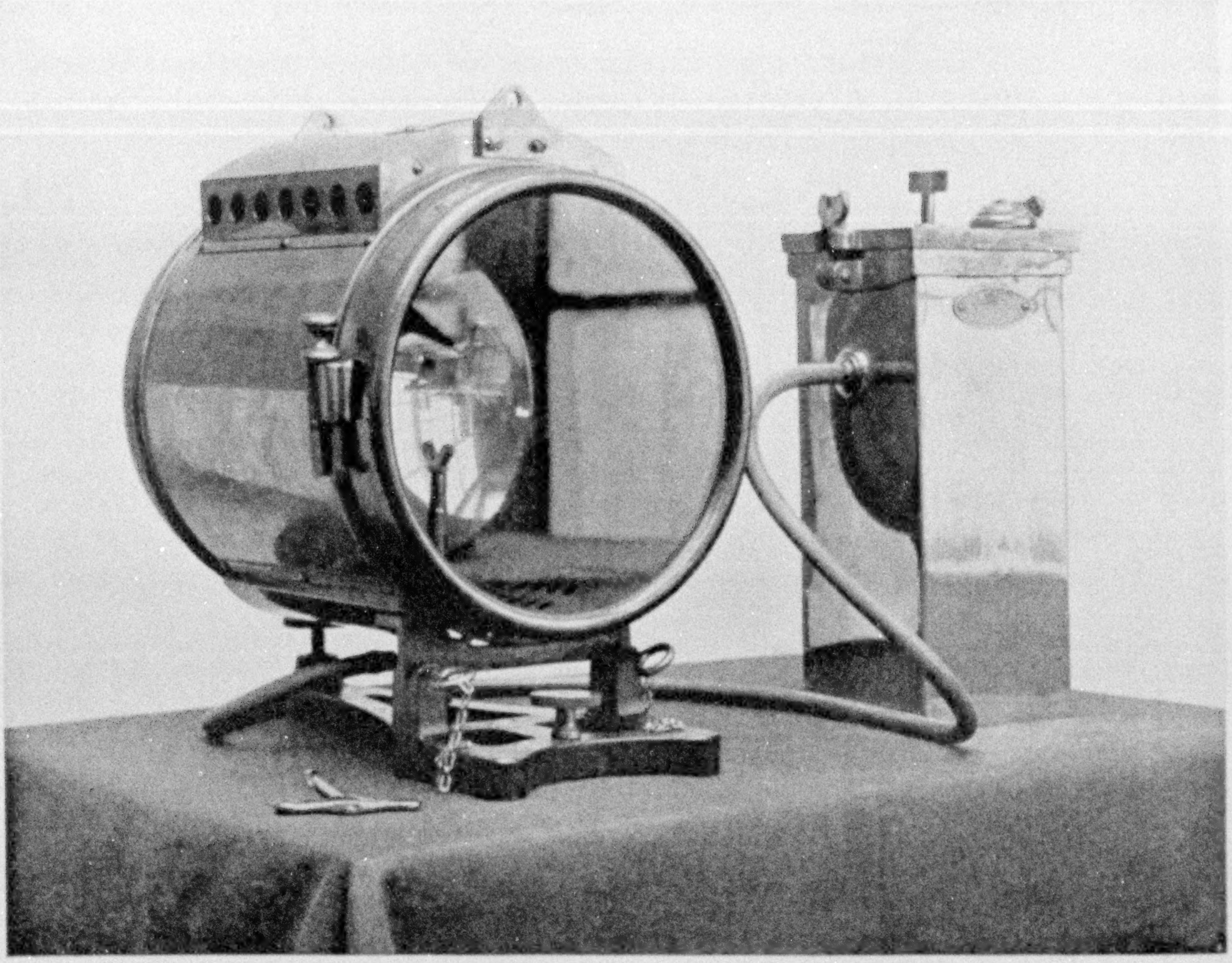
So carefully have all the different surveys been made that they may all be put together and the lines fit perfectly. Any one familiar with surveys made on each side of a river, and how hard it is to get them to fit together, in ordinary practice, can understand what accuracy has been required to bring all the different surveys of North America into such harmony that from every point already fixed a skilled man from the Coast and Geodetic Survey could run his line right back to the North American Datum, in Kansas.

Of late years many cities have found it necessary to order a triangulation of their territory, in order to connect their surveys with those of the Coast and Geodetic Survey. There was much confusion encountered in the offices of city surveyors in trying to connect their layouts of streets, lots, parks, and other works and areas with the big federal survey. These triangulations cover such cities as New York, St. Louis, and Boston, and are now in progress in San Francisco and Cincinnati. Maryland has had all her oyster beds located by the United States triangulation surveys and their positions fixed with reference to the United States Datum and the stars.

DETERMINING THE EARTH'S SHAPE

The work of the Survey in measuring with great accuracy the surface of the United States has not only had its practical uses, but its scientific uses as well. The diameter of the earth is the primary yardstick by which all celestial distances are measured, and the exact length of this astronomical yardstick cannot be known until the shape of the earth is determined with great accuracy. So important is this work that 21 nations are linked together in an international agreement for the support of the International Geodetic Association and the promotion of its work of earth-measurement. A central bureau is maintained at Telegraphenberg, Prussia, and triennial conferences of the science of geodesy are held.

The work of the Coast and Geodetic



ONE OF THE POWERFUL LIGHTS WHICH FLASH SIGNALS 100 MILES

These signals are used to flash from one triangulation station to another making observations at night. The lamps are lighted by acetylene gas, and the reflectors are so powerful that the light has been seen through the telescope of a theodolite for a distance of over 100 miles (see page 665).

Survey has proven so accurate that the world now recognizes the figure of the earth determined by it as the best available, and for that reason it was adopted as the standard by the International Convention of Astronomers, recently held at Paris.

MAPPING WITH CAMERAS

In recent years the Survey has been employing the camera in making its topographic surveys, thus being able in some instances to do away with the plane table. This method of topographic surveying is especially useful in such regions as Alaska, where difficult country and bad weather conspire against the successful use of the plane table. The cameras are specially prepared, cross wires being fixed to the lens and the scale being so arranged that they appear with the view upon the photographic plate. The chief precaution necessary is that each prominent topographic object shall be photographed from at least two points (see page 674).

The work of triangulation and precise leveling sometimes requires the endurance of great hardships and affords many adventures. These involve all the dangers and experiences that go with scaling the Alps or climbing a Mt. McKinley. Tugging instruments up a mountain-side, where the slightest misstep would carry the bearer to the bottom of some terrible chasm or precipitate him into some madly rushing, ice-cold mountain stream, is no summer-evening picnic at best.

Now one of the Survey engineers may be heading a party on the 141st meridian that divides Alaska from Canada, where today they scale a great mountain peak within the Arctic Circle, tomorrow battle

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SURVEYING FROM A MOUNTAIN TOP

In making a geodetic survey, absolutely flat country is a much greater obstacle to the surveyor than a range of mountains. Indeed, a high mountain, commanding extensive views in all directions, is often a godsend, as it may serve as the apex for triangles drawn in all directions. Here is such a mountain, Uncompahgre Peak, on the summit of which, 14,289 feet above the sea, a triangulation station was erected when surveying the Colorado arc (see page 665).

with an epidemic of smallpox among the Eskimos, and a few days later are down in a little valley where the mosquitoes are so thick that even a horse cannot graze unless it be protected by nets. Now one of them is at work with a party in the Rocky Mountains, fording streams that are bordered with quicksands, shooting down rapids that threaten every moment to swamp canoe, party and all.

But whatever the task of the men, they learn to live with the thought uppermost in their minds that he who is willing to bear the heaviest burden will find every other member of the party ready to help him bear it.

Men go to Africa to hunt big game; they go to South America to explore new rivers; they go to Switzerland to climb high mountains; they go to the heart of Africa and the interior of Tibet to find strange people; but the men who make the basic surveys upon which our knowledge of the shape of the earth and our maps are based get all the thrills and all the experiences that come to them all, and get back to Washington safe and sound and ready for the prosaic work of writing up their notes.

A MAGNETIC SURVEY

Accurate surveying such as is involved in the triangulation work of the Coast and Geodetic Survey would not boot much on land or sea were definite information not at hand concerning the behavior of the magnetic needle. The magnetic needle refuses to stay put anywhere, and varies from the true north in different degrees in different parts of the earth. For instance, in London it changed its direction 35 degrees in the 232 years preceding the outbreak of the War of 1812. Then it began to swing back again, and up to the present time has moved east nearly 10 degrees. The change is by no means as rapid in the United States as it is in London, but at the same time it is enough to interfere with every survey if the rate of change were not known. As the rate varies between London and Washington, so it varies in different parts of the United States.

In order to determine the declination of the magnetic needle innumerable observations have been made all over the United States, and the exact declination for each place has been ascertained. In the section east of the Rocky Mountain States there is scarcely an area 50 miles square where the variation of the needle has not been measured and passed on to the State and local surveyors, and in few places are these points of needle observation more than 20 or 30 miles apart. The method by which the variation at a given point is found is to compare the north of the compass needle with the true north revealed by the theodolite. The difference is the variation of the needle.

THE MAGNETIC NEEDLE IS NEVER STILL

If the behavior of the needle is important on land, it is even more so on the sea. A boundary a mile long fixed by the compass in Maryland in 1802 would now have its one end some 525 feet away from the original location if the survey now did not allow for the change in the variation of the compass since 1802. But on land points can be located without the use of the compass. On sea the compass is yet indispensable, and the navigator must constantly allow for its continual changes, else some fine night he would find himself high and dry on a reef when he thought he was miles away from it. For instance, the declination of the compass at Key West is 2 degrees east, while at New York it is 10 degrees west. Did a skipper steer through his voyage from Key West to New York on the assumption that the declination was the same at New York as at Key West, he would run into the coast somewhere south of a point 19 miles west of New York.

The Survey maintains observatories at Cheltenham, Maryland; Baldwin, Kansas; Sitka, Alaska; Vieques, Porto Rico, and near Honolulu, Hawaii, where the behavior of the magnetic needle is under constant observation and study. There are places where the compass needle varies from forenoon to afternoon enough to make a difference of from 5 to 20 feet in a mile-long line, and places where there have been sudden and unaccountable changes such as occurred

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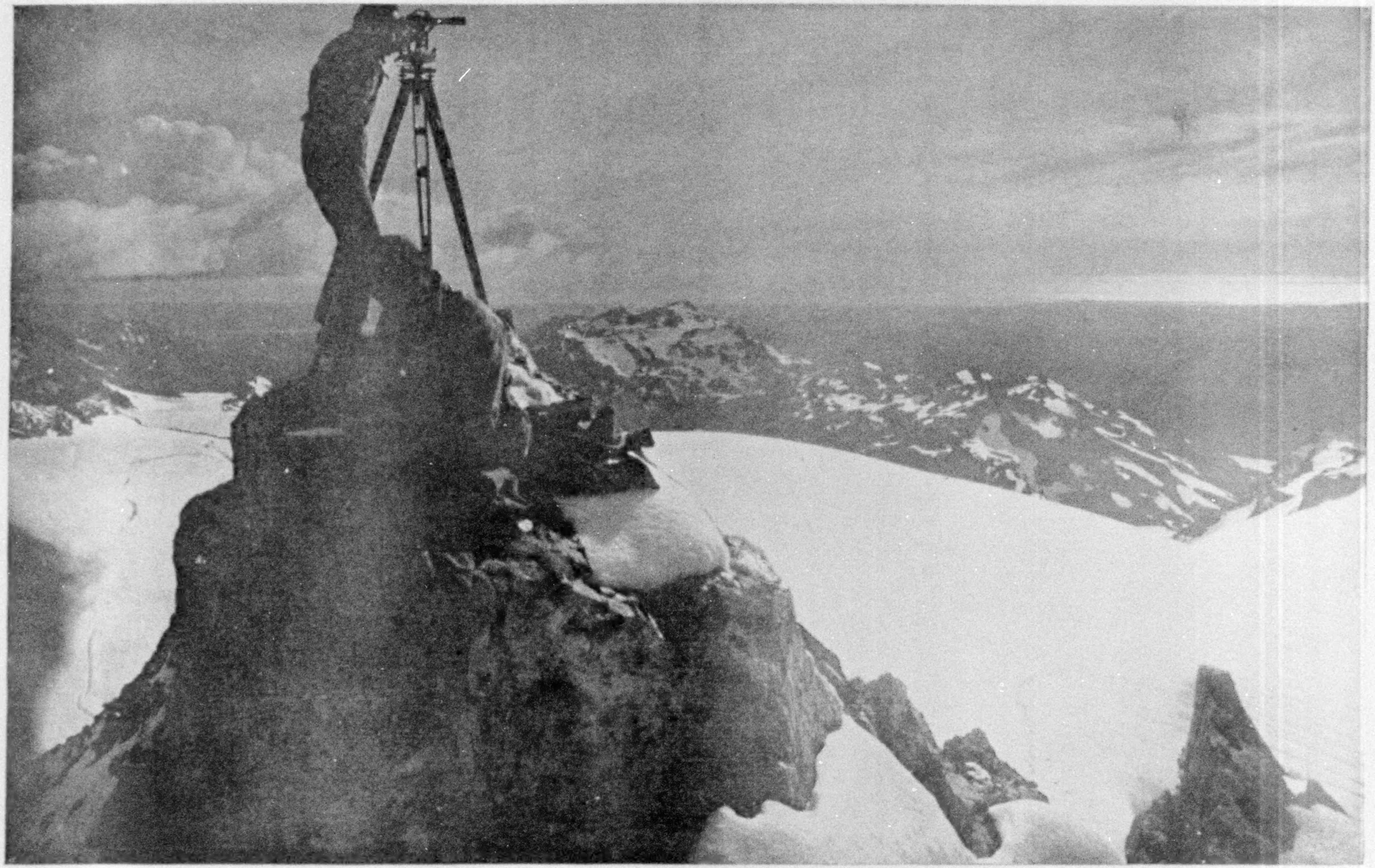


SURVEYING UNDER DIFFICULTIES IN ALASKA

This picture gives an idea of some of the difficulties encountered by the surveyor. To obtain the necessary elevation the instrument had to be taken to the top of a snow-clad mountain peak, which was so small that it hardly afforded room for the instrument and the two observers at Los Angeles during a violent storm, when the needle shifted more than 1½ degrees in a few hours. All these phenomena are carefully studied in the hope of discovering ultimately the secrets of magnetism.

A magnetic map of the United States is made showing the lines of equal magnetic declination and those of equal dip. For instance, the map for 1905 shows that 5 degrees east declination runs almost due north and south, while 10 degrees east crosses the Canadian boundary near the Lake of the Woods, Minnesota, and swings around to the southwest, reaching the Pacific Ocean across Lower California. The 70-degree line starts in in the neighborhood of the southern Delaware boundary, and sweeps through northern Virginia, southern Ohio, and middle Nebraska, reaching the Pacific through southern Washington.

The magnetic map is always changing, but the information is carried with it which enables the mariner or the surveyor to make the necessary corrections at any given point.

PRECISE LEVELING

The United States Coast and Geodetic Survey has established precise levels in every section of the United States, marking the altitude at convenient points by means of bench-marks. These marks are the beginning points of all local surveys, such as are necessary in railroad location, water-works planning, and the like. The maximum error allowed in this work is one-fifth of an inch to the mile. In recent years a large number of long circuits have been made, and where these are closed the maximum error has been about one five-hundredths of an inch to the mile. This applies to the precise leveling of over 4,000 miles of line.

Precise leveling is now done with a spirit-level attached to a telescope designed and made by the Survey itself. By the use of a nickel-iron alloy changes due to temperature conditions are practically eliminated. One of the officers of the Survey declared that he could take one of these levels, put it into the hands of the youngest engineer in the Survey, and get better results than the best engineer the American Society of Civil Engineers could get with any other level. After inspecting the Coast and Geodetic level the challenge was not accepted. Many other countries have adopted this instrument in all their leveling operations (see page 675).

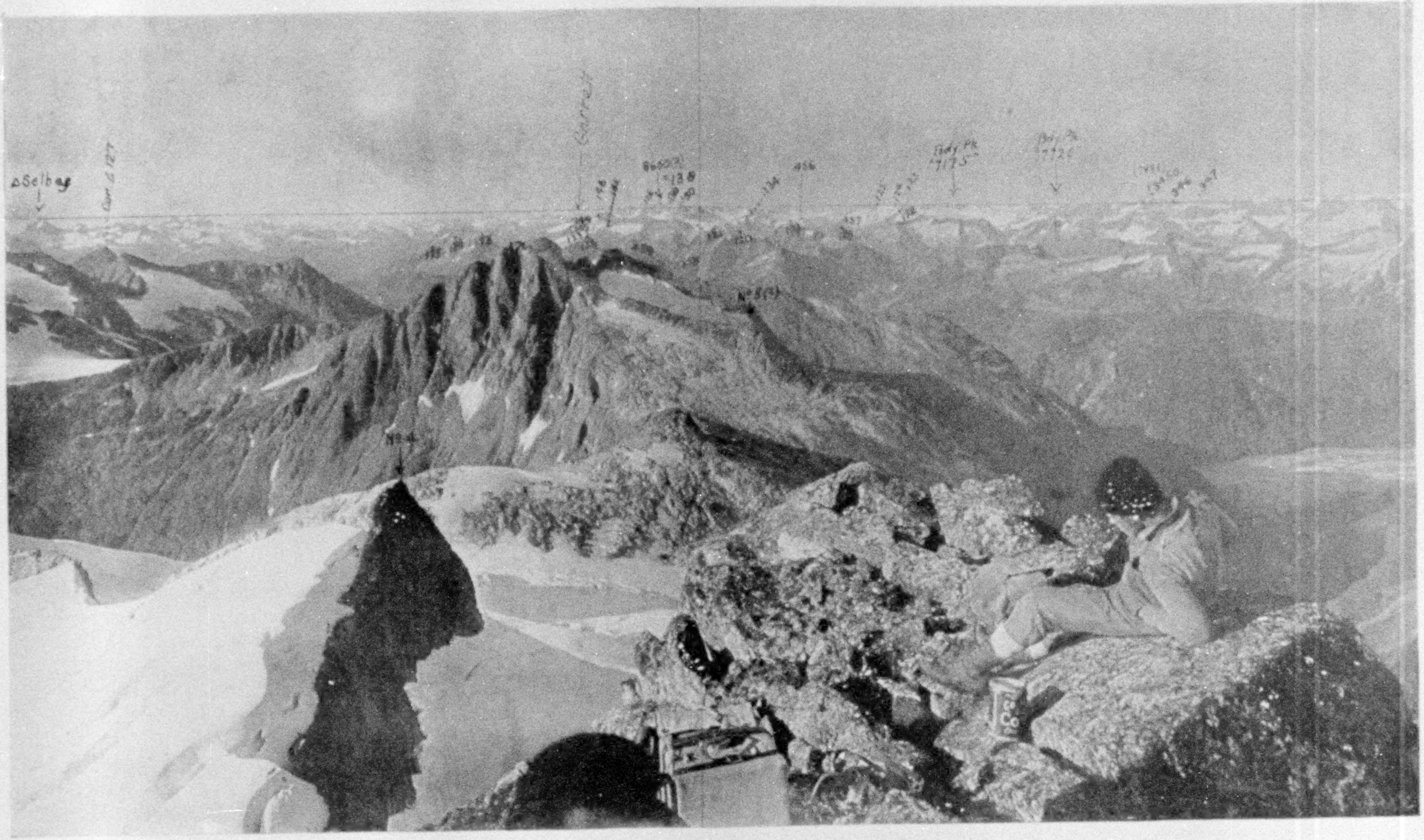
Some leveling is done by the measurement of vertical angles, although this system is not regarded as accurate enough for the finest work of the Survey.

THE TIDES

In addition to its other work the Coast and Geodetic Survey keeps the records of the tides, and furnishes tables which show the fluctuations for every hour and every day for as much as a year ahead. The Survey has made a great mechanical prophet that can predict the recurrence of tides as accurately and as unerringly as an astronomer can predict the coming of a solar eclipse. Its brain of brass can, with the aid of one man, calculate the recurring tides as rapidly as a hundred brains of flesh and blood can do it (see page 676).

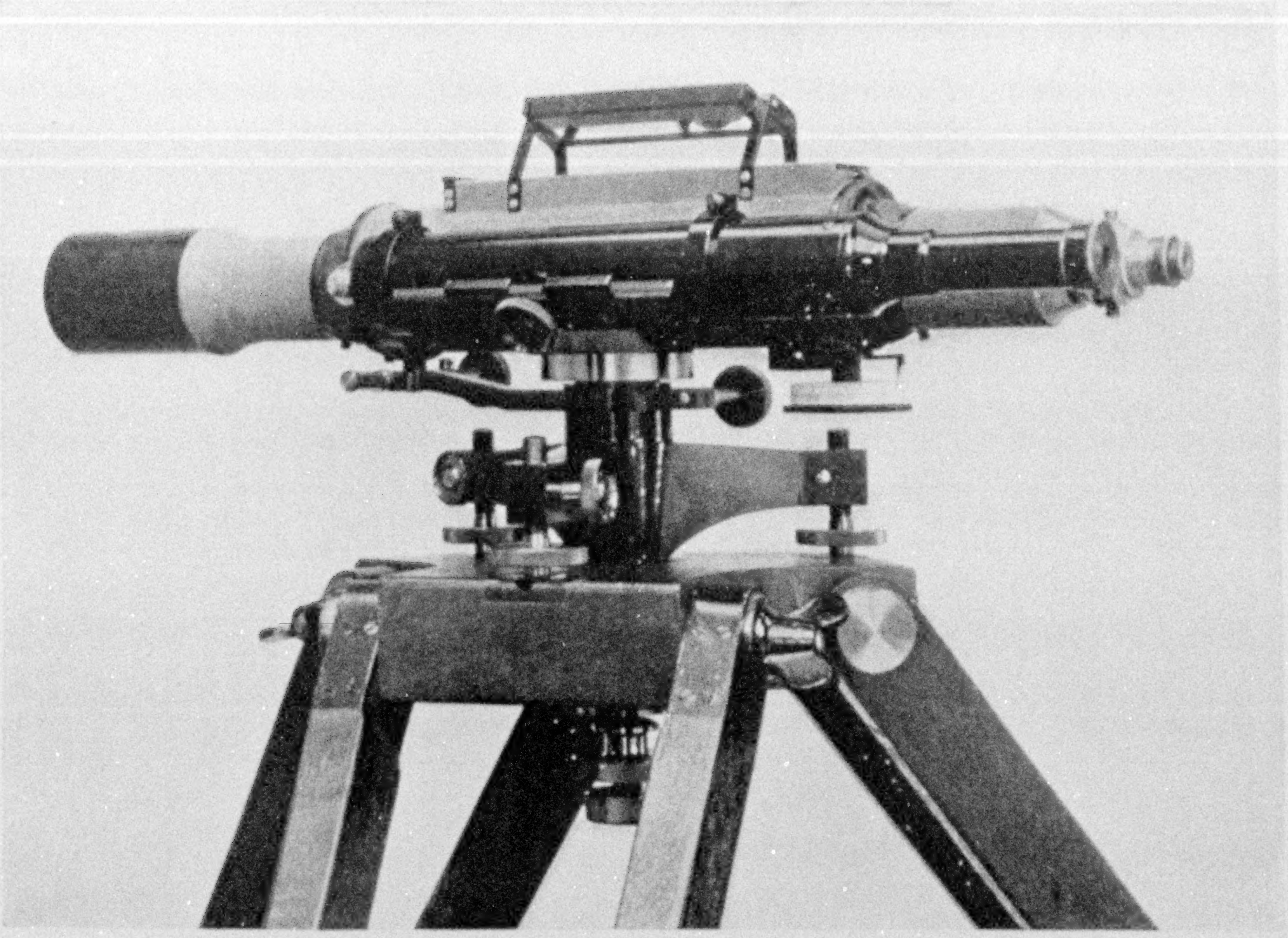
The machine is known as "United States Tide Predicting Machine No. 2." The operator turns a crank until it stops. He then copies the readings on a number of dials and removes from the machine a roll of paper on which is plotted a tidal curve. This process is repeated until tide-tables have been prepared, showing the height to the nearest tenth of a foot of every high and every low tide at a given seaport for every day in the year. This is repeated for some seventy big seaports and in less complete form for 3,000 others.

There are 37 factors in the making of tides, sometimes all of them entering into the process and sometimes fewer of them. We know that they are produced by the force of gravity between the earth, the sun, and the moon, and the tide-predicting machine is simply a mechanism that brings these bodies into their proper relations for every hour and every day of the year, and automatically computes the effect of these relations on the tides and registers it on the dials.



MAP-MAKING FROM PHOTOGRAPHS

This photograph was taken by a camera specially designed for photo-topographic work (see page 669). The rear frame of the inner camera box is supplied with notches to mark the horizon and the principal lines. All these notches print on the edges of the negatives, giving ready means for checking distortions in the prints, and at the same time showing the scale in conjunction with the cross-lines. In this picture, reading from left to right, two triangulation stations are shown, then a camera point (marked No. 4), then the height (in meters) of four peaks, etc. From such photographs it is possible to construct an accurate map of the region within the field of vision.



THE MOST PERFECT PRECISE LEVEL IN THE WORLD

This level was designed and made by the Coast and Geodetic Survey and is recognized by engineers as being superior to every other known make. It can produce more rapid and efficient work for a less cost than any other type. It has been officially adopted not only by the government of the United States, but also by those of India, Mexico, Canada, and Egypt (see page 673).

We say that it is simply a mechanism that does these things; but when it is remembered that the machine has 15,000 parts, and that 15 years of careful work were required in its construction, we understand that it is not very simple after all.

The records made by this machine are used wherever men sail the seas, and as the question of a foot or two in depth on a dangerous shoal may involve the lives and the property on a passing ship, while the commercial prosperity of a port may depend upon information about the tides, this great machine serves more than a theoretical purpose. Its tabulations do for the waters what the American Ephemeris and Nautical Almanac does for the stars in aiding navigators.

THE WONDER OF THE TIDES

The tides are among the most remarkable phenomena in the world of nature, and they give rise to many peculiar notions concerning the level of the oceans. The tide at Panama, for instance, rises much higher than the tide at Colon, and this leads many people to think that the Pacific has a higher level than the Atlantic. As a matter of fact, however, while the tidal fluctuations on the Atlantic side have a range about 2 feet and those on the Pacific side a range of about 20 feet, the level of the oceans is the same. The difference is caused by the narrowing shoreline of Panama Bay, which takes a broad expanse of water as it enters the bay and narrows it down as it sweeps into the V-shaped entrance. What it loses in breadth it must make up in depth, and hence the higher tides on the Pacific side of the Isthmus at Panama.

The same phenomenon is witnessed in the Bay of Fundy, where at the head of

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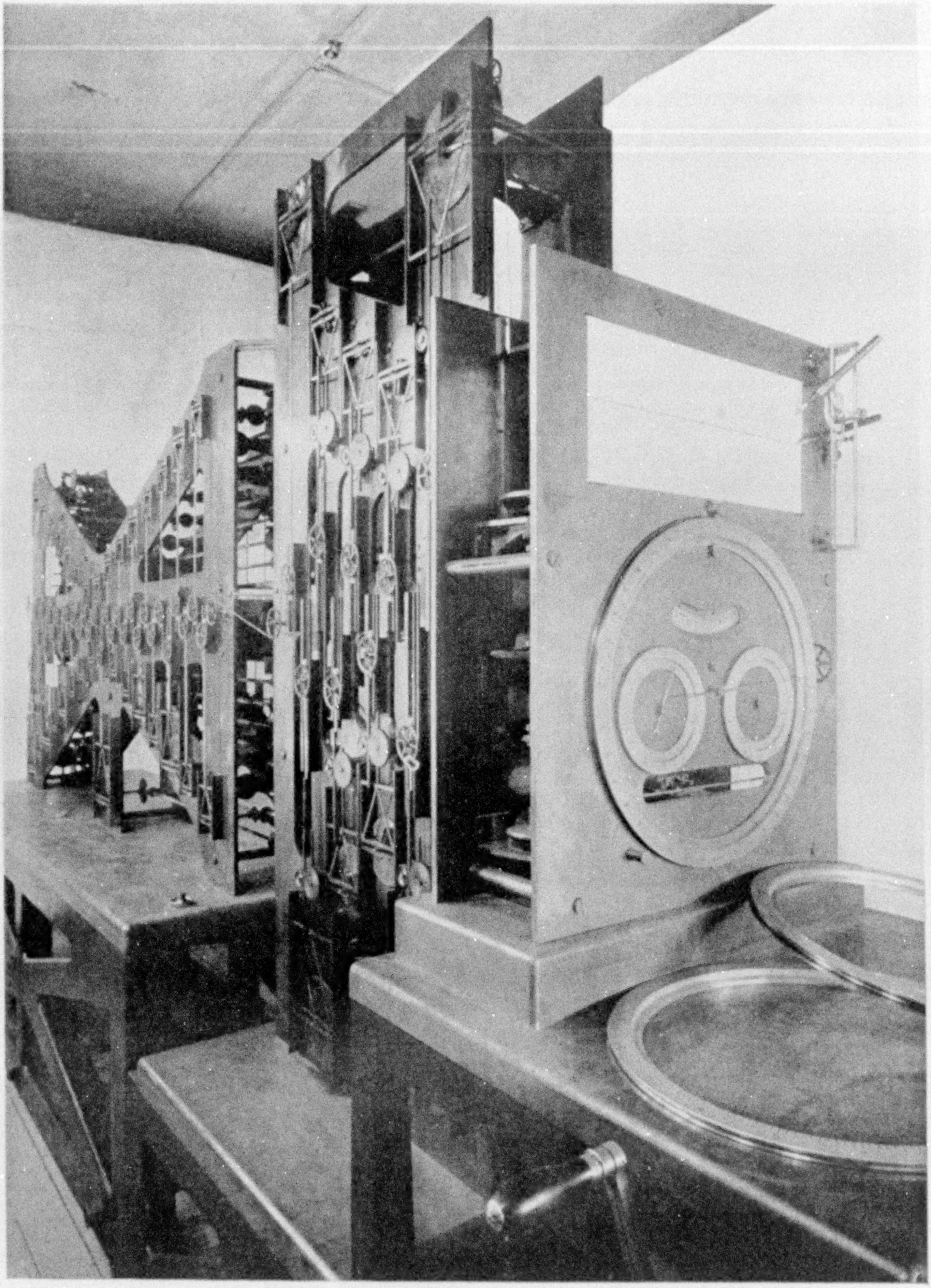


A MACHINE THAT PROPHESIES

This machine—the only one of its kind in the world—will predict the tides at any seaport as much as 100 years in advance. It is used in the compilation of the tide tables issued each year by the Coast and Geodetic Survey. A simple turn of the handle will record on the dials the time and height of the water at high or low tide for each day in the year at any selected port, and at the same time trace a tide curve which forms a permanent record of its predictions. The machine—an improvement of Lord Kelvin's tide-curve machine—was designed and constructed by the Coast and Geodetic Survey and is a triumph of applied science.

the bay the rise is 55 feet above sea-level. At spring tides the water in the Bay of Fundy is 19 feet higher than in the Bay of Verte, only 15 miles distant.

The mechanical division of the Survey is a wonderful place to visit, as may be inferred from the fact that it can make theodolites so accurate that in the triangulation between the Maryland and Georgia base-lines the discrepancy was less than half an inch in 30 miles, and that it can make precise levels so accurate that the maximum error is an inch to 500 miles. In addition to the marvelous tide-predicting machine, it has a circular dividing engine with which it constructs the scales on the graduated circles. This engine has a spindle 4 inches in diameter, tapering three-quarters of an inch to the foot. This spindle must fit into its bearing so nicely that it has less than 1/10,000 of an inch play. Before the dividing engine can be set to work the room must have been subjected to a uniform heat for several days, in order that every part of the walls may be uniformly warm, so as to prevent air-currents from interfering with the accuracy of the work. The room is kept at blood heat, so that the presence of the supervisors of the engine's operations do not interfere with its accuracy.

The Coast and Geodetic Survey was founded in 1807 under President Jefferson, and was then known as the Coast Survey. Its greatest work dates from 1878, when it was broadened to its present scope. Today it employs 700 men, and has become one of the Federal government's most important bureaus, serving well the practical needs of every-day life, and at the same time pioneering in paths of science in a way that has added and is adding to the fund of human knowledge on the subjects with which its investigations deal.

HONORS TO COLONEL GOETHALS

The Presentation, by President Woodrow Wilson, of the National Geographic Society Special Gold Medal, and Addresses by Secretary of State Bryan, the French Ambassador, the German Ambassador, and Congressman James R. Mann

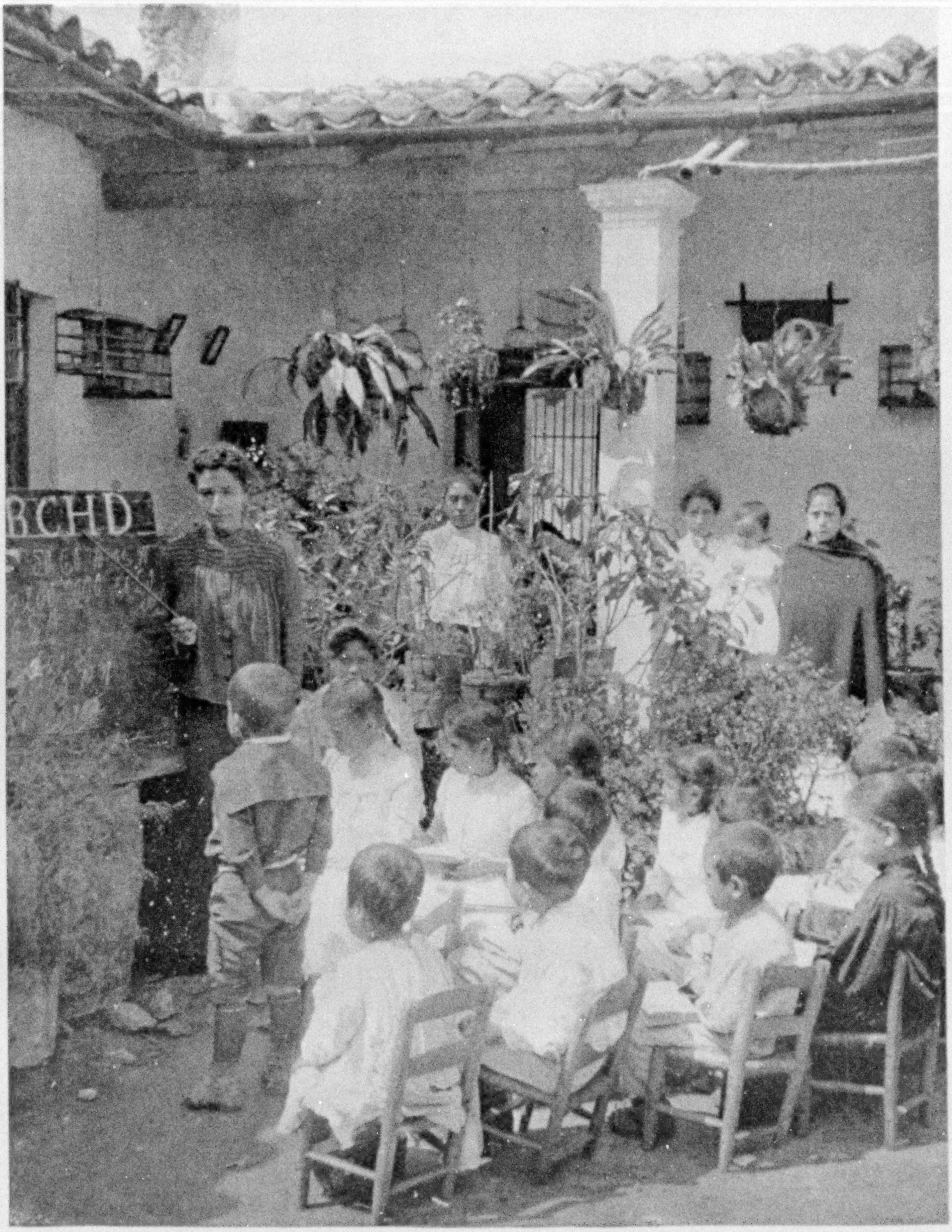
THE ninth annual banquet of the National Geographic Society was held at the New Willard Hotel, Washington, D. C., on the evening of March 3, 1914, and was made the occasion of the Society's formal recognition of the eminent services of Col. George W. Goethals, U. S. A., to geography and to the world as the builder of the Panama Canal.

Among the members of the Society and guests present, numbering more than 800, were the President of the United States, with a majority of the members of his Cabinet—Secretary of State Bryan, Secretary of the Interior Lane, Secretary of the Treasury McAdoo, Secretary of Agriculture Houston, Secretary of the Navy Daniels, Secretary of War Garrison, Secretary of Labor Wilson; members of the Supreme Court, Senators and Representatives from nearly every State, diplomatic representatives of every great foreign nation, officers of the Army and Navy, and men and women prominent in the world of science and letters.

The tables were arranged in the form of a huge gridiron and the banquet hall beautifully decorated with flowers and flags. Behind the speakers' table, high overhead, there was a great blaze of electric lights spelling the union of the oceans and the completion of the canal in the words

ATLANTIC—GOETHALS—PACIFIC

The tributes which were paid to the guest of honor by the speakers of the evening were enthusiastically received by the vast audience. Colonel Goethals was accorded an honor which has been achieved by few men—the distinction of receiving at the hands of the President of the United States a gold medal in



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"A, B, C" IN SPANISH—FLOWERS, BIRDS, AND VISITORS AT A PRIMARY SCHOOL: JALAPA, MEXICO

While the children of the peons seldom go to school, either because of indifference to the advantages of education or lack of school facilities, the children of the well-to-do enjoy educational advantages equal to those of other countries.

recognition of his services to his country and the world.

President Wilson's presentation speech conveyed to the great engineer the thanks of the nation, and when he said that the name of Goethals was now written where only the wiping out of our present civilization could cause it to be forgotten, and called upon him to rise and receive the highest honor in the gift of the National Geographic Society, the outburst of applause which swept over the vast audience almost drowned the voice of Colonel Goethals as he tried to find words in which to voice his appreciation of the honor done him.

It was plain that he felt more at home "dividing the land and uniting the world" at Panama than he did in receiving a medal in recognition of his work.

Every speaker of the evening lauded the work of the Americans at Panama and praised the men to whom the world owes the canal.

Before presenting the French Ambassador, Mr. J. J. Jusserand, the Toastmaster, Secretary Bryan, announced his election as an Honorary Member of the National Geographic Society, "for the double reason that his nation deserves a part in this great undertaking, and because of the personal interest that he has always manifested in the work of this Society."

At the end of the speaking Secretary Bryan, the Toastmaster, proposed a toast to the wife who had stood by her husband so loyally during the long and trying siege of work that had been his lot at Panama.

The special medal of the Society is made of heavy Roman gold and bears the following inscription:

"This special medal of the National Geographic Society is awarded to George Washington Goethals, to whose ability and patriotism the world owes the construction of the Panama Canal, March 3, 1914."

A special medal of the National Geographic Society has been awarded only twice before—to Robert E. Peary, December 15, 1909, "for the discovery of the North Pole, April 6, 1909," and to Roald Amundsen, January 11, 1913, "for his Antarctic achievements, resulting in the attainment of the South Pole, December 14, 1911."

ADDRESS BY DIRECTOR GROSVENOR

Mr. President, Members of the National Geographic Society:

Owing to the sudden, but not serious, illness of our learned and loved President, Dr. Henry Gannett, and also to the illness of our Vice-President, Dr. Tittmann, the duty of welcoming you here this evening has unexpectedly come to me at the last moment.

On behalf of the Society, I express our very deep appreciation of the fact that the President of the United States, Hon. Woodrow Wilson, whom we all most devotedly serve, has by his presence honored the tribute which we are giving to the man whose genius built the Panama Canal.

Before introducing the Toastmaster of the evening, I ask your indulgence for a few moments while I read a few statistics about the work of the National Geographic Society. The 12 months since we last met in this hall have made the most successful year in the history of the National Geographic Society. Seventy-four thousand new members have been added to the enrollment, making the total present membership of the society two hundred and sixty-one thousand.*

These are distributed in sixteen thousand towns, villages, and hamlets in the United States and in two thousand cities in foreign countries. California in proportion to its population is our banner State, with a membership of twenty-five thousand. New York City leads our cities, with an enrollment of nineteen thousand. There is not a community of one hundred white people in the United States where a member of our Society cannot be found.

The explorations and educational work of the Society during the past year have kept pace with the increase in membership. We have been continuing our researches in Alaska, in Peru, and elsewhere.

Our Magazine has become perhaps the greatest educational journal in the world.

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*The membership on June 15, 1914, is 289,000.

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It reaches thousands of schools and libraries and is inducing more than one million people each month to read of geographic matters. One month's edition, if the copies were placed one above another, would make fifteen piles as high as the Washington Monument, or, if placed on a book-shelf, would reach from the White House to the Capitol and back again. The Magazine yields the funds to pay for our exploration; for, unlike other scientific societies, our Magazine supports the Society instead of being a drain upon the organization.

These figures are given that all here may appreciate that the ambition of the Society to increase and diffuse geographic knowledge and help the cause of international good-will is being realized.

Through our Magazine we are bringing our citizens nearer to other peoples and also bringing other peoples nearer to us.

It is now my privilege to present one of the most distinguished members of our Society, Hon. William Jennings Bryan, the Secretary of State, who will direct the proceedings of the evening.

THE TOASTMASTER, WILLIAM JENNINGS BRYAN, SECRETARY OF STATE

The task of a Toastmaster is always the easiest on the program and easier tonight than it usually is, because those who are to speak to you do not require to be presented with an elaborate explanation. Especially is that true of those who appear as the first and second.

A medal given by this Society will be presented to the guest of the evening, and when the greatest Geographic Society of the world is to honor the most illustrious member of his professon on the globe, because of the successful completion of the most gigantic engineering feat in history, there is but one person to present the medal, the President of the United States.

ADDRESS BY PRESIDENT WOODROW WILSON

I am now so unaccustomed to public speaking that it was with genuine hesitation on my own account that I accepted the invitation of this evening. But I accepted it as a matter of course when the great compliment was paid me of extending it to me, because it seemed to me that it was not only a personal privilege which was offered, but a duty encumbent upon me as a representative of the government of the United States. It seemed to me that, speaking for that government, as well as for the distinguished Society in whose name I am now presenting this medal, it was my duty as it was my privilege to be here.

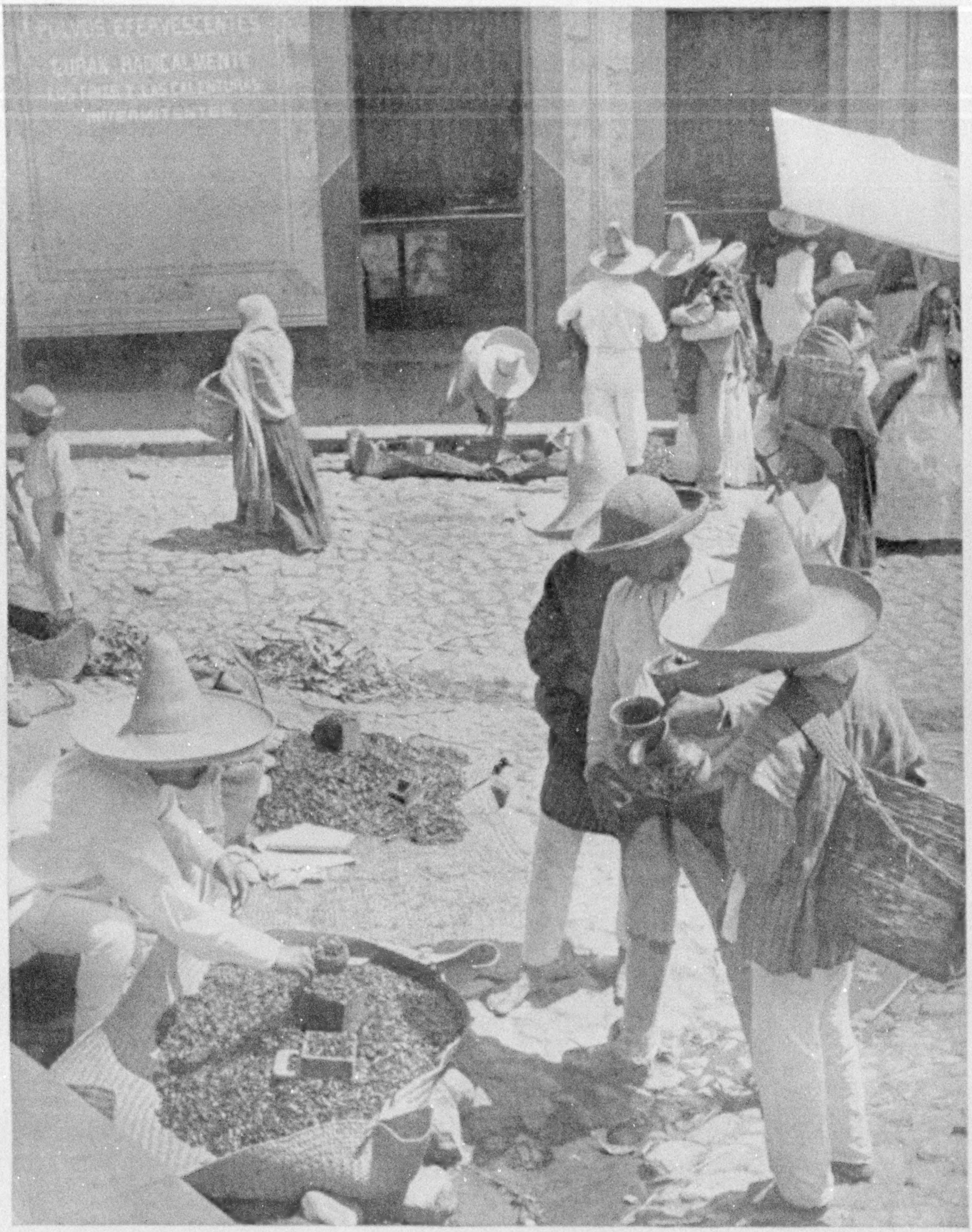
I am here to do what I suppose is an unusual thing for a Society of this sort. It generally confers its honors upon those who have disclosed geography rather than upon those who have altered it. It is a sort of advertiser and custodian of the globe, and it is now about to honor a gentleman who has had the audacity to change the globe.

The engineering profession is one of the few creative professions. Those of us who have attempted to be literary men conceive that we have created conceptions of the mind, but we never can produce them in court. They are never visibly upon exhibition. But the magic of the engineer is that he can change the face of nature and show the work of his hands, and that it is in some deep sense creative in character. The life of mankind on the globe is altered, for example, by the cutting and the use of the Panama Canal.

It fails the imagination to think what this work will accomplish. It will create new neighbors. It will generate new friendships; it will make a new atmosphere of rivalry and of generous association. The whole tendency of the routes of trade will be changed, and the routes of trade are the routes of enlightenment. Only when nations touch one another do they cease to be provincial and look out upon the great tasks of humanity, instead of confining themselves to the relatively selfish tasks of their own domestic development, and it is only as we export and import ideas that civilization becomes thoroughly established.

We have, therefore, to honor tonight the greatest living representative of this extraordinary profession.

It seems to me natural, if I may say so with apologies to some of our friends present, that the greatest engineer living should come from the United States.


POLVOS EFERVESCENTES
CURAN RADICALMENTE
LOS FRIOS Y LAS CALENTURAS
INTERMITENTES

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SELLING "HOT" PEPPERS—THE MEXICAN'S CHOICEST DELICACY: MARKET AT CORDOBA, MEXICO

"Hot food" with the Mexicans is more a matter of seasoning than of exposure to heat. Chili con carne and hot tamales have come with their fame to our own shores, but they are only two of the more than 57 varieties of "hot" things the Mexicans eat with evident relish and coming appetites. And "hot" peppers form the keynote of them all.

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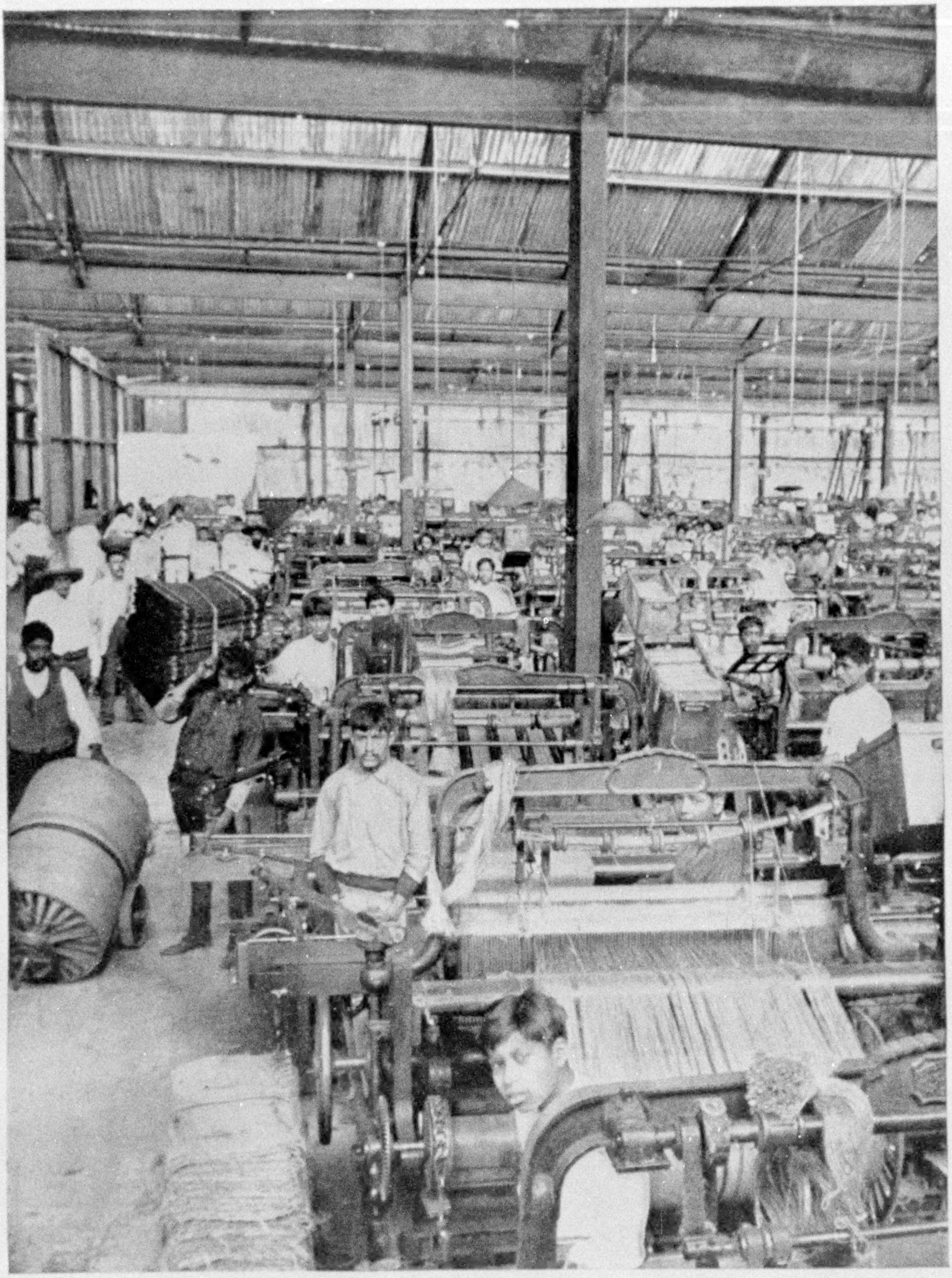

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A SPLENDIDLY EQUIPPED CARPET FACTORY OF SANTA GERTRUDE, NEAR ORIZABA, MEXICO

During the rule of Porfirio Diaz textile factories, employing thousands of laboring people, came into existence in Mexico. They were mostly owned by foreign capital, and through them a middle class was gradually being developed.

The United States has made the world very uncomfortable, but it has at least done so by the exercise of extraordinary dynamic qualities. It is not one of the statical nations of the world. It is one of the nations which has disturbed equilibriums, which has cut new paths for the thought and action of mankind.

And now there is to be elevated and kept always on high at this new gate, upon which men are to enter the roads of new experience, a name which will not be blotted out until and unless the whole civilization of the world should change, the name of Colonel Goethals.

The government of the United States lent him to the world, and he has done this thing for the world, for it is our proud boast that we have cut this highway for all the sea-going ships of the world.

GAILLARD, GORGAS, SIBERT, HODGES

I take it for granted that we do not tonight forget that distinguished group of men who have been associated with Colonel Goethals; that gallant and devoted soldier, Colonel Gaillard, who gave his very life to see that a great work was done at the Culebra Cut; that man who made so much of this work possible, Surgeon General Gorgas, by knowing how to hold disease off at arm's length while these men were given leave to work; also Colonel Sibert, who built the Gatun Dam and created the Gatun Lake, making it look to the eyes of the uninitiated as if nature had done the work over which he himself presided, and also Colonel Hodges, who made the locks and the machinery by which these great things are administered.

But we are merely tonight acknowledging the presiding character and genius which drew all the elements of this work together, which made it a work done by colaborers, not by rivals; work done as if it were the conception of a single mind; work done in the spirit of service and self-effacement which belongs to a great servant of a great government. There is nothing selfish in the eminence of Colonel Goethals. It is representative of a great profession. It is representative of a great government. It is representative of a great spirit.

I am glad that this thing was not done by private enterprise, and that there is no thought of private profit anywhere in it, but that a government put itself at the service of the world and used a great man to do a great thing. That is the ideal of the modern world, that the services to mankind shall be commonly shared.

And so I esteem it a real privilege, acting on behalf of this Society, to present to you, Colonel Goethals, this very beautiful medal. It is made of mere gold, and gold is of no consequence in this connection, sir; but it speaks, in the most precious metal we know, the gratitude and the admiration of the nation.

RESPONSE BY COL. GEORGE W. GOETHALS, U. S. ARMY

Mr. President, it is an easier task to build the Panama Canal than it is for me to find words to express appreciation of the honor conferred upon me by the National Geographic Society and the distinguished manner in which the presentation of the medal has been made. This medal represents the satisfaction of the National Geographic Society at the practical completion of the canal and its approval of the services rendered. Those services are not only individual services, but national services. The French were the pioneers in the undertaking. But for the work that they did on the Isthmus we could not today regard the canal as practically completed. But for the English we probably would not have known the means of eradicating malaria; the death rate would have been great. Among individuals we have national representatives in the Spanish and the English in our laboring force.

The canal has been the work of many, and it has been the pride of the Americans who have visited the canal to find the spirit which animated the forces. Every man was doing the particular part of the work that was necessary to make it a success. No chief of any enterprise ever commanded an army that was so loyal, so faithful, that gave its strength and its blood to the successful completion of its task as the canal forces.

And so in accepting the medal and thanking the National Geographic Society for it, I accept it and thank them in the name of every member of the canal army.

SECRETARY BRYAN

The Isthmian Canal is an international work. It connects the oceans that wash the shores of every land, and through it will pass the commerce of all the nations. It is fitting, therefore, that we shall have as participants in the program of this evening those who in an eminent way represent the nations which will take conspicuous advantage of the opportunities which this canal will offer, and at our table tonight we have as one of the speakers the representative of one of the great nations of Europe, one of the nations whose growing fleets are known in all the corners of the earth. I have the honor to call upon His Excellency, the Ambassador from Germany, to give his testimony to the greatness of this undertaking and pay his respects to the genius under whose guidance the work has been accomplished.

ADDRESS BY THE GERMAN AMBASSADOR, AMBASSADOR VON BERNSTORFF

When I received the kind invitation to attend this splendid banquet, I accepted with the greatest pleasure because it afforded me the occasion to renew my friendly relations with Colonel Goethals, the greatest engineer of these days, who has presented to the world an engineering feat which in ancient days would have been called one of the Seven—I do not know how many wonders of the world we have now.

I had also wished to meet the charming wife of Colonel Goethals, with whom I had formerly spent a very pleasant week on the ocean. I was not disappointed in that, as I had the pleasure of sitting next to her at dinner.

In one way, however, I must confess that I was very much disappointed this evening, because I had been told that I was to have a very good time tonight and a night off from speaking. A quarter of an hour ago, however, I was asked to say a few words to you, and I am very glad to have this opportunity to thank you for the splendid hospitality afforded me.

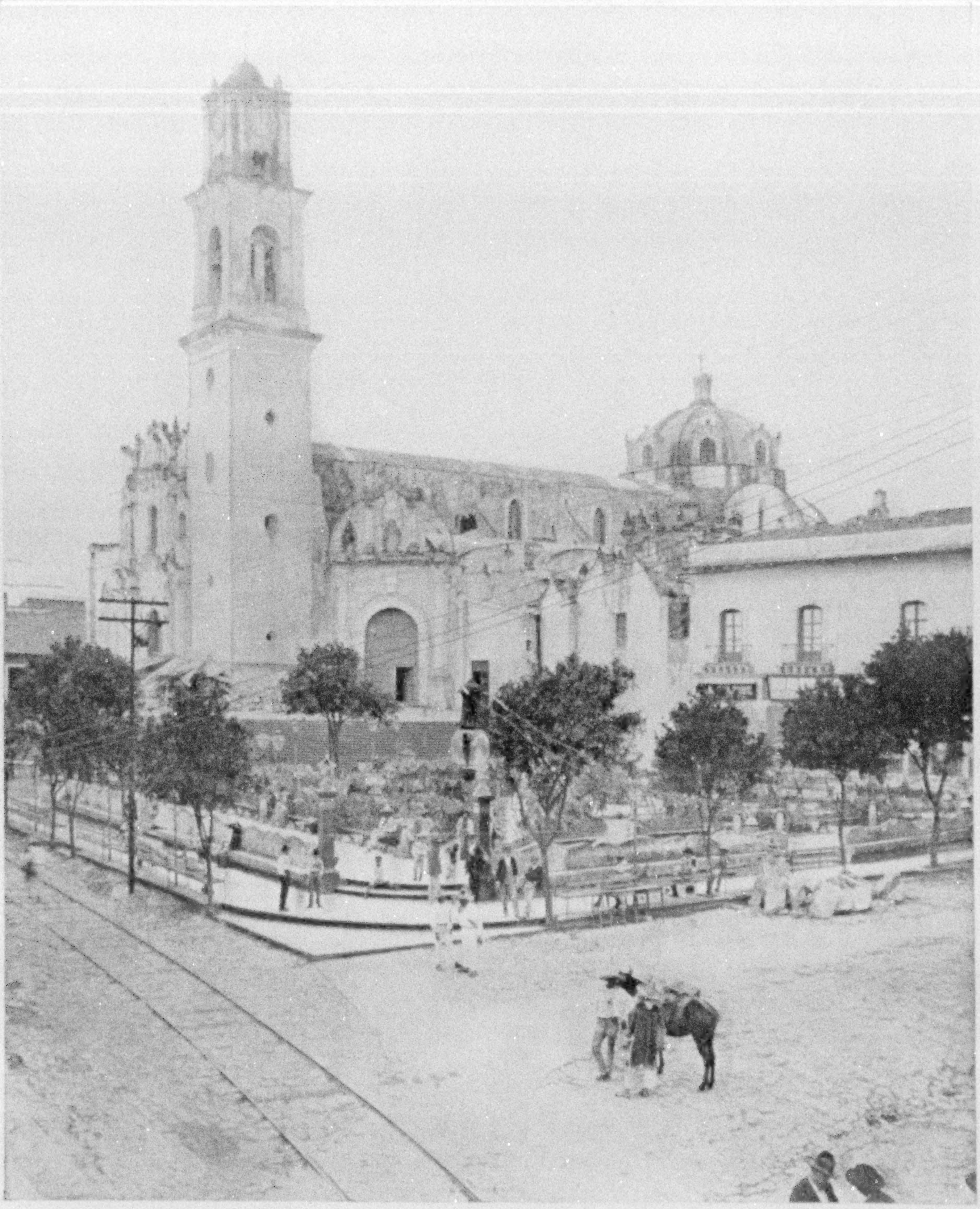
The presiding officer of your Society told me before that this Society was carrying on an investigation—one of the many investigations of these days—which was to result in finding a way by which people should work only two weeks in the year and live in happiness and plenty all the rest of the time. Now, if your Society manages to achieve this wonderful result I hope it will be applied to the foreign ambassadors to the United States, because that would mean only fourteen speeches a year instead of about one hundred or more.

These diplomats always feel at home in a society of geographers, because we are what I might perhaps call practical geographers. Without knowing where we are going or whence we come, we are sent all over the globe and we regard the whole universe as our home. It is not always so pleasant as it is here, and we are therefore very glad when on this large globe we find such a pleasant and hospitable home as we all find in the United States.

As a German, I would like to remind you of an incident in the life of perhaps the greatest of my compatriots, Goethe, who a hundred years ago, shortly before his death, was sitting among his most intimate friends, and had just received a book written by Alexander von Humboldt, a name which is familiar to geographers all over the world. It gave a description of Mexico and the surrounding countries, and after having read this book Goethe said to his friends, "I am a very old man, and I have only one wish: that is that I could live long enough to see the Panama Canal built."

He added that he was sure this canal would be built by the people of the United States, because he saw by the energy and enterprise with which they colonized the whole west of this great country that they would surely not miss the opportunity of building this canal. I wish I could evoke his spirit to be among us today. He might find it a queer coincidence that his name is so much like the name of the great man who built this canal.

Before sitting down I wish to thank you once more for your kind hospitality and for the great pleasure you have afforded me tonight.



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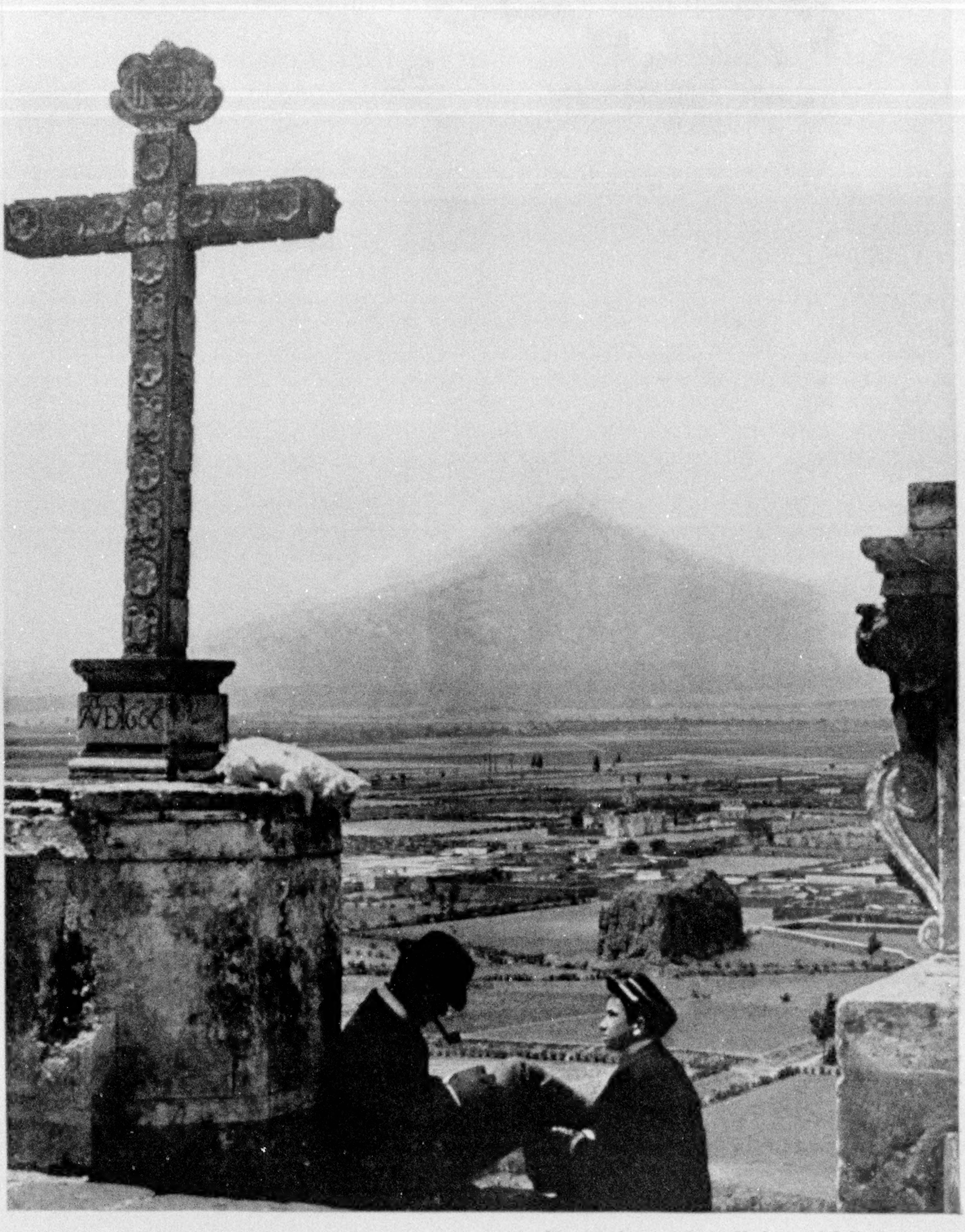
THE CATHEDRAL—THE GREATEST OF MEXICAN CHURCHES: NORTHWEST FROM THE NATIONAL PALACE ROOF, CITY OF MEXICO

The cathedral of Mexico City is said to be the largest church in the Western World. It stands on the site of the great temple of the Aztecs, where tens of thousands of prisoners were sacrificed to the sun. Its foundations are composed almost entirely of Aztec images. Its inside dimensions are: length, 387 feet; width, 177 feet, and height, 179 feet. It is estimated that it cost some $2,000,000.

XUM



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THE MAGNIFICENT POPOCATEPETL FROM THE LARGEST OF THE ANCIENT AZTEC PYRAMIDS AT CHOLULA, MEXICO

The landscapes on the great Mexican plateau are always filled with interest. A dozen cities surround each of the great Mexican volcanoes, and whether Popo is viewed from Puebla, Mexico City, Amocameca, Cholula, or Cuautla, it is always the same graceful mountain (see also pages 630 and 641).

XUM

SECRETARY BRYAN

To build this canal it was not only necessary that some should dream of it, but it was necessary that some one should finance it, and whenever in this country the government needs money it must go to Congress, which controls the nation's purse. We have gone to Congress and Congress has supplied us liberally. All bills have been paid thus far. But it is appropriate that as we are not quite through we should keep on good terms with those who must furnish the balance. And so tonight, with the wisdom that has characterized it in so many ways, the National Geographic Society has taken care to provide that a representative of the House of Representatives should be here to receive your thanks for the money already given and your supplication for that which is needed. I have the honor of introducing to you Congressman Mann, of Illinois.

ADDRESS BY HON. JAMES R. MANN

I can assure the Toastmaster and those who are here that there never has been and that there never will be any difficulty in obtaining all the money that is necessary for the construction and the operation of the Panama Canal, and that is especially true while the Committee on Appropriations is presided over by the genial and handsome gentleman from New York, Mr. Fitzgerald.

I served in the House of Representatives on the committee having jurisdiction in regard to the Isthmian Canal when it was first proposed by Col. William P. Hepburn, of Iowa, the chairman of that committee, that the Isthmian Canal should be constructed not by a private corporation, not by a private enterprise, but should be constructed and owned by the United States itself. We owe a debt of gratitude to him for that proposition, the result of which was the negotiation of a new treaty between the United States and England and the final undertaking of this government by the government itself to construct the greatest civil engineering enterprise which the world has ever known.

The dream of ages was about to come true, the longing of the centuries was to be realized, the hope of the navigators for those years in the past was soon to become a reality, and the two oceans were to be united. There stood the work in contemplation; it only needed the man. Others retired; others despaired. This man retained his confidence; others quit. He kept his commission; others failed; he succeeded. The man and the work came together when Colonel Goethals was placed in charge of this great undertaking.

No one who has visited the Canal Zone and watched the operations of the force there will be surprised to know that that force idolizes the Chief Engineer. He spoke a moment ago of how each man in the work performed his duty with a single eye to true devotion; but you would not know from that that all along the line of the canal, from ocean to ocean, as the Chief Engineer passes by every employee there speaks lovingly, "There goes the old man." And "the old man," as they lovingly call him, tips his hat to every employee, from switchman to his chief lieutenant. He has made them love him; he has made them devoted to the cause. He, with those under him, has made this great undertaking reflect credit upon government, upon national enterprise, upon the American people, upon humanity, upon our own government, because he has succeeded in doing that which no one dared to really hope could be done; that the government in this manner would be able to spend hundreds of millions of dollars in the construction of the great work by direct employment of government officials and employees without serious scandal. It never has been done before on such an enterprise on such a scale, and I hope that our country will recognize that peace may have its victories as well as war.

The heroes of the past have been made in war. Here is a hero whom we ought to put upon a pedestal as an inspiration to our children and those who live now and who come after, that those who do their full duty in time of peace may enjoy the same lofty ideals as those who win in war; and I hope that the title "Colonel" Goethals will soon be gone, and that we will salute him as "General" Goethals.

SECRETARY BRYAN

It might be expected that all Americans sharing in the honor which Colonel Goethals has brought to the nation would be glad to pay tribute to him. It is to be expected that when there is the conjunction, the preparedness and opportunity which constitute success, that we should all rejoice. It is to be expected that we shall all behold with joy and admire the flower that springs from the place where great preparedness and great work meet. But I am glad that on this occasion we can have as a representative of the outside world one whose people began the work which our people completed. This meeting tonight would not be what it ought to be if we did not hear from one of that great nation which first called the world's attention to the fact that it was possible for man to unite these two oceans in perpetual wedlock, and we are fortunate in having as the spokesman of that nation one who can speak so sympathetically to our people, while with such fidelity he represents his own.

The National Geographic Society has asked me to present a certificate of honorary membership to the gentleman whom I am about to call upon. It is presented to him for the double reason that his nation deserves a part in this great undertaking and because of the personal interest that he has always manifested in the work of this Society. Therefore it is my pleasure as it is my honor to present this certificate of membership to His Excellency, J. J. Jusserand, the French Ambassador, and to ask him to represent the nation that gave the initiative to the canal to which we give the completion.

ADDRESS BY THE FRENCH AMBASSADOR, J. J. JUSSERAND

I lack appropriate words to express my gratitude for the signal honor that has just been bestowed on me, especially when I think that it comes from this great National Geographic Society, whose members are as numerous as the sands of the sea—or nearly so, and in which American science is represented by a man like Dr. Graham Bell, the American Army by such an explorer, a pioneer, an early discoverer as General Greely; the American Navy by the man who reached the goal at which so many had aimed and planted the flag of the United States at the North Pole, Admiral Peary.

It is a very great and important thing to hold a record, and on the present occasion, among your honorary members, I certainly hold one—the record of undeservedness. I have no doubt—and in saying so I am acting as a well-wisher of your Society—that I shall hold it long.

I feel in a way guilty in not having better titles, when I think of my youthful preparation and of having been early taught many of the arts useful to explorers: to ride, swim, jump, climb, and even walk. Thus, when small boys, carrying all our luggage on our backs, we did a good deal of exploring in, it is true, not very remote countries; some, however, with whose language we became familiar only in after-life. We were very proud to be able to address at need a priest in Latin and get from him directions as to our way. But I shall blushingly confess, in the presence of my German colleague, that we were once confronted with the terrible fact that, being in a small out-of-the-way place in his country, none between us four could remember more than half the word railway. *Eisen* came to the mind of one of us, and nothing further. We missed our train, and shall never forget that the whole word is *Eisenbahn*.

Of real explorations, I have none to my credit. I set foot on four of the five parts of the world, but from the Nile to Seattle, or Petersburg to Panama, I saw nothing but what others had seen. My chief journeys to far-off lands have been through a medium greatly to be commended, and which consists neither in railroad, steamer, horse, nor camel, but in the National Geographic Society's Magazine. Through it you can visit all the world and know the secrets of the most remote places. Happier than Mahomet, who ordered the mountain to come, but it would not, so that he had to go to the mountain, we beckon to lake and peak, ruins, icebergs, cities, and deserts, and behold, here they come in their true shape and colors!

In my undeservedness one thing pleases

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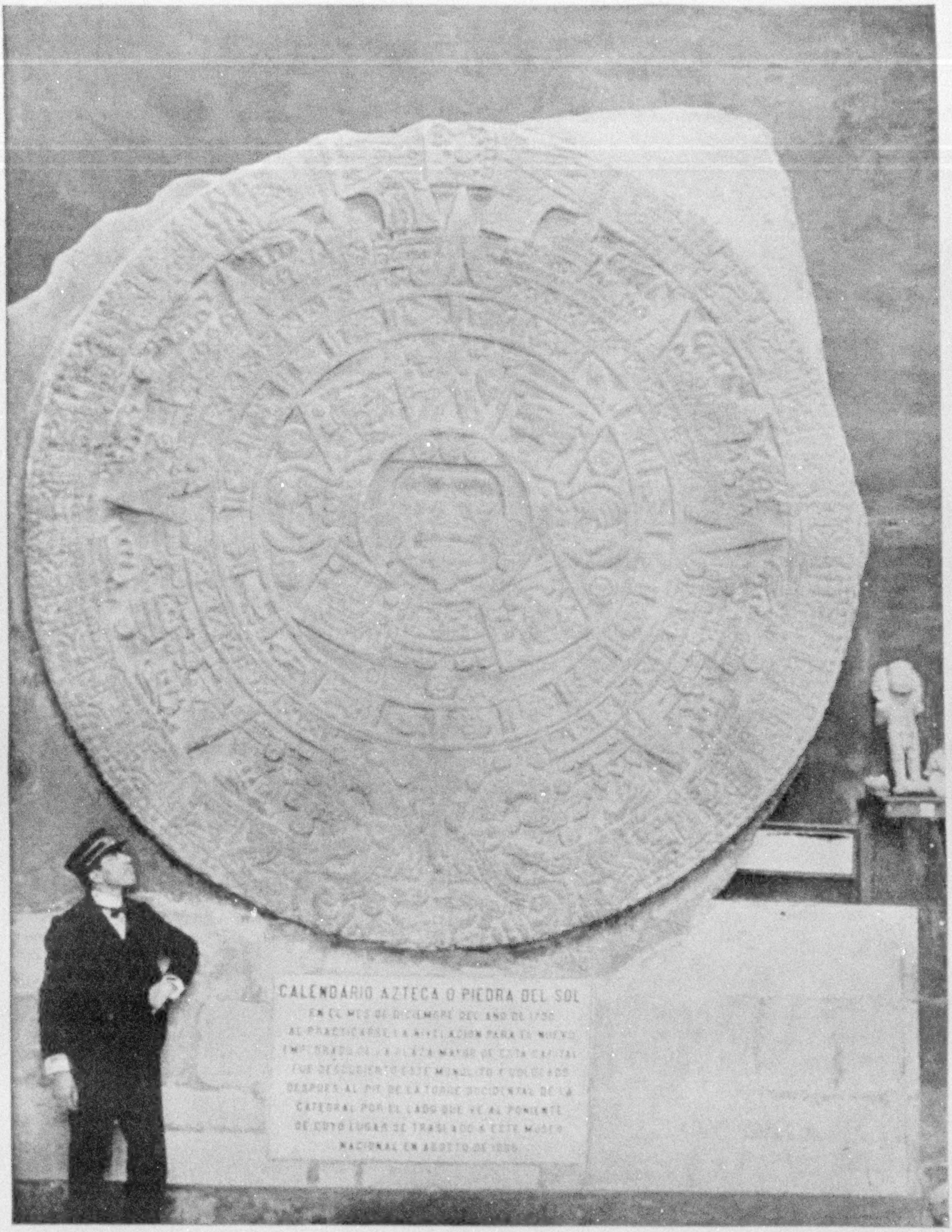

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WONDERFUL WITNESS TO AZTEC ENLIGHTENMENT: CALENDAR STONE DISCOVERED IN 1790 AND NOW IN THE NATIONAL MUSEUM, MEXICO CITY

This stone is of basaltic porphyry, 22 feet in diameter and 3 feet thick, and weighing about 24 tons. It was first found in the subsoil of the present cathedral square of Mexico City about the middle of the seventeenth century, but Archbishop Montufar, fearful that it would influence the Indians to revert to idol worship, caused it to be reburied. The central figure of the carving represents the sun. Within the first ring are the names of the Aztec years; within the second ring the Aztec days of the month. Prescott says that the accuracy with which they adjusted their festivals to the movements of the stars and fixed the length of the tropical year was with a precision unknown to any of the great philosophers of antiquity.

me—that which has made up for my lack of merit—namely, your friendly disposition toward me, and, I feel confident, your consideration for my country. If I have done little, my country has done much. Since our republic has been established a renewal has been apparent of the exploring spirit of the sixteenth and seventeenth centuries.

France has produced new Laudonières, new Cartiers, new La Salles, new Champlains. We have built in Asia and Africa the largest colonial empire France ever possessed, and we have done so more by discovery than by war. The French are "harborous to strangers," said Sir Thomas Overbury. That characteristic has been a great help.

The first thing we did wherever we got was to build a road, then a school, and in that school we had the natives taught not only, nor even chiefly, our language, but theirs, and even in many places their own theology. Our officers have acted at need, in large numbers, under various skies, as instructors, builders, agriculturists, archeologists, artesian-well drillers, trying not to destroy, but to improve; to which many American travelers have borne a testimony in which we take pride.

The value of the diploma you have bestowed on me is enhanced by the fact that I receive it on an occasion the hero of which is Colonel Goethals. I have long known him, and I may say that it was, on my side, a case of friendship at first sight. It is difficult to meet him and not understand the cause of that great influence he has over his fellow-men; one feels at once that he cannot ask any one to do anything but what is right, proper, wise. Any man in his senses acts as he is bidden by him. I have seen him, so to say, in action on that great canal along whose banks so many of my compatriots have found their last resting place; where I saw, with some pride, the white line, not so very near the summit, where we stopped in the Culebra, and I raised my hat to some of our dredges and machinery, still at work after so many years and still contributing to the mighty task.

I had the honor of visiting the canal in the President of the Commission's yellow car, familiarly called "Goethals' yellow peril," because people who prowl about the tracks must move rapidly when it comes, if they do not want to change from this world to another. In the Zone one single man was all-powerful, and his chief strength did not lie in the regulations which had defined his office, but in his moral influence and the respect with which he was surrounded.

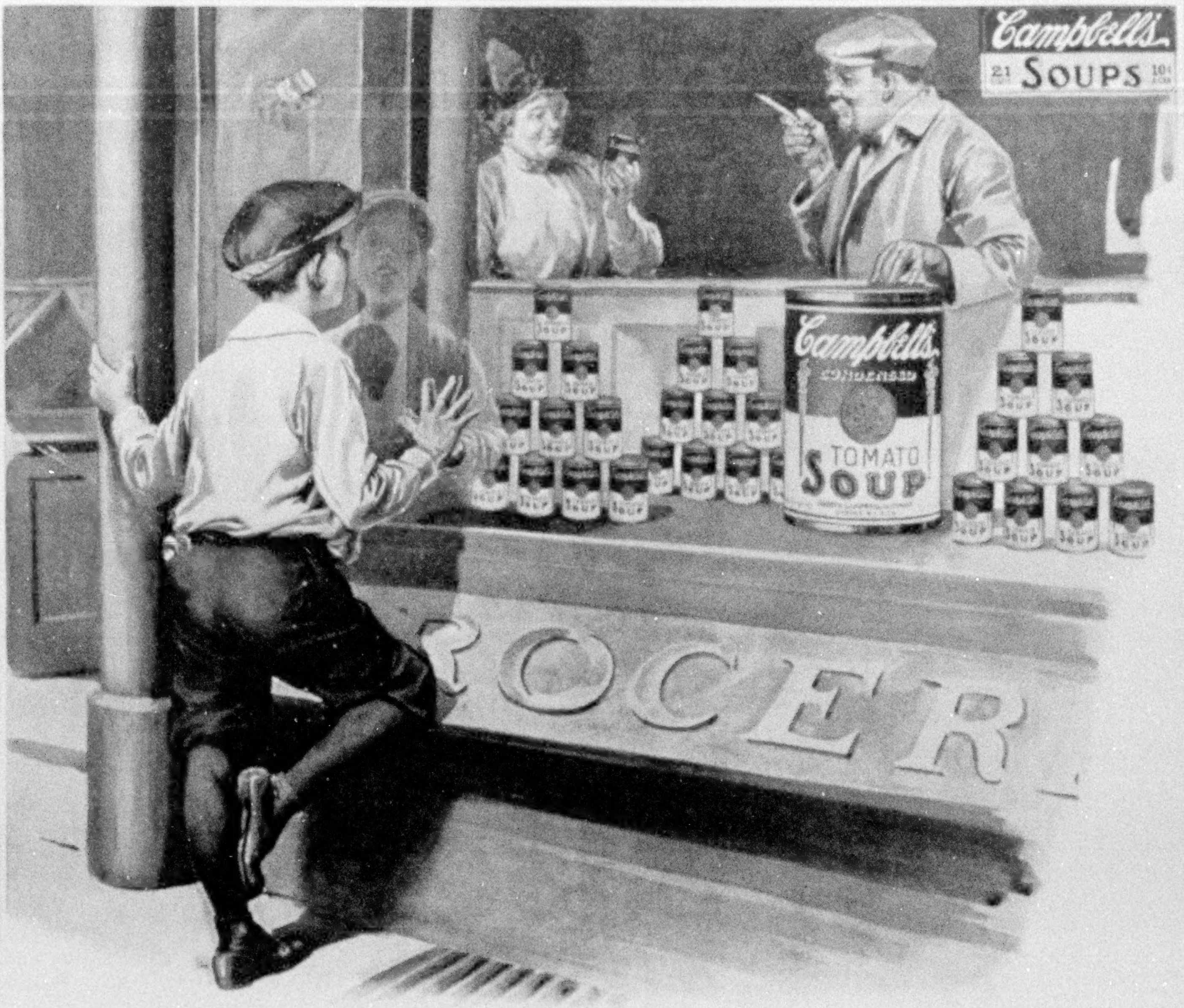
We left the canal not knowing which to admire most, the Babylonic grandeur of the material work then nearing completion or the strength of character in one man's breast, which set in motion and regulated the forces used in the perfecting of the enterprise.

I am thankful to you for having given me this occasion to add to American good wishes and congratulations for the work and for the man, French good wishes and congratulations.

SECRETARY BRYAN

While the program as printed is completed, we are not quite through. No one will be called upon for a speech, although there is one subject that has not yet been presented—the happy coincidence of name and accomplishment. How appropriate that it should have been George Washington Goethals who did this work. Who will say that there is no inspiration in a patriotic name?

But I am not willing that this meeting shall conclude until I have performed a task laid upon me by this Society. We have heard from representatives of our own and other countries, and the President has spoken for all the people of the United States in presenting this medal of honor. I am sure that you desire to express yourselves, each one for himself or herself, and I am sure that you will welcome the opportunity that I am asked to give you. While the name of the man will be inscribed upon all the monuments that are erected at Panama, the name of the wife who has stood by him in his work and shared the dangers and the trials of the task will not be forgotten. As a fitting conclusion of this most appropriate occasion, I ask you to rise and drink to the life, health, and prosperity of Colonel and Mrs. Goethals.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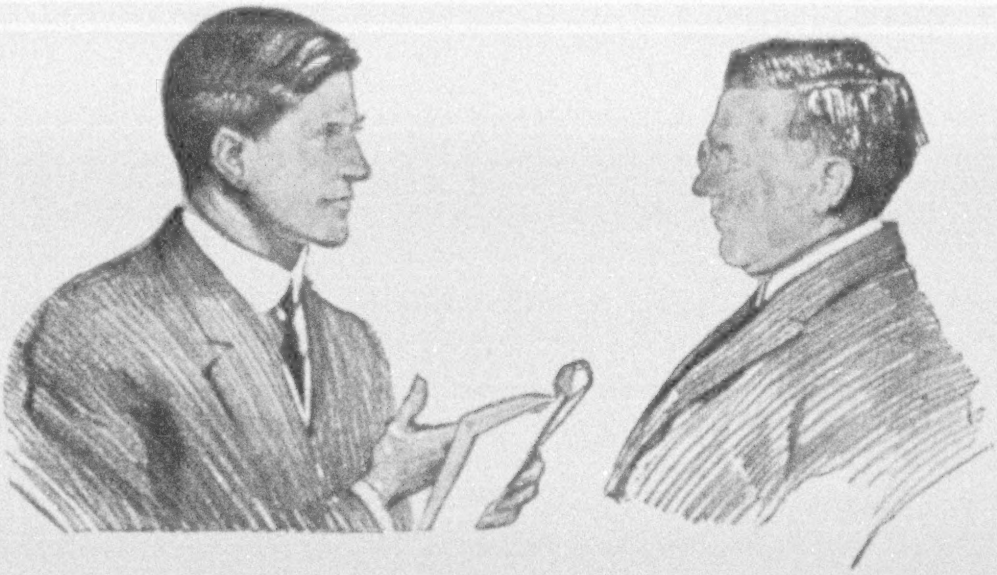

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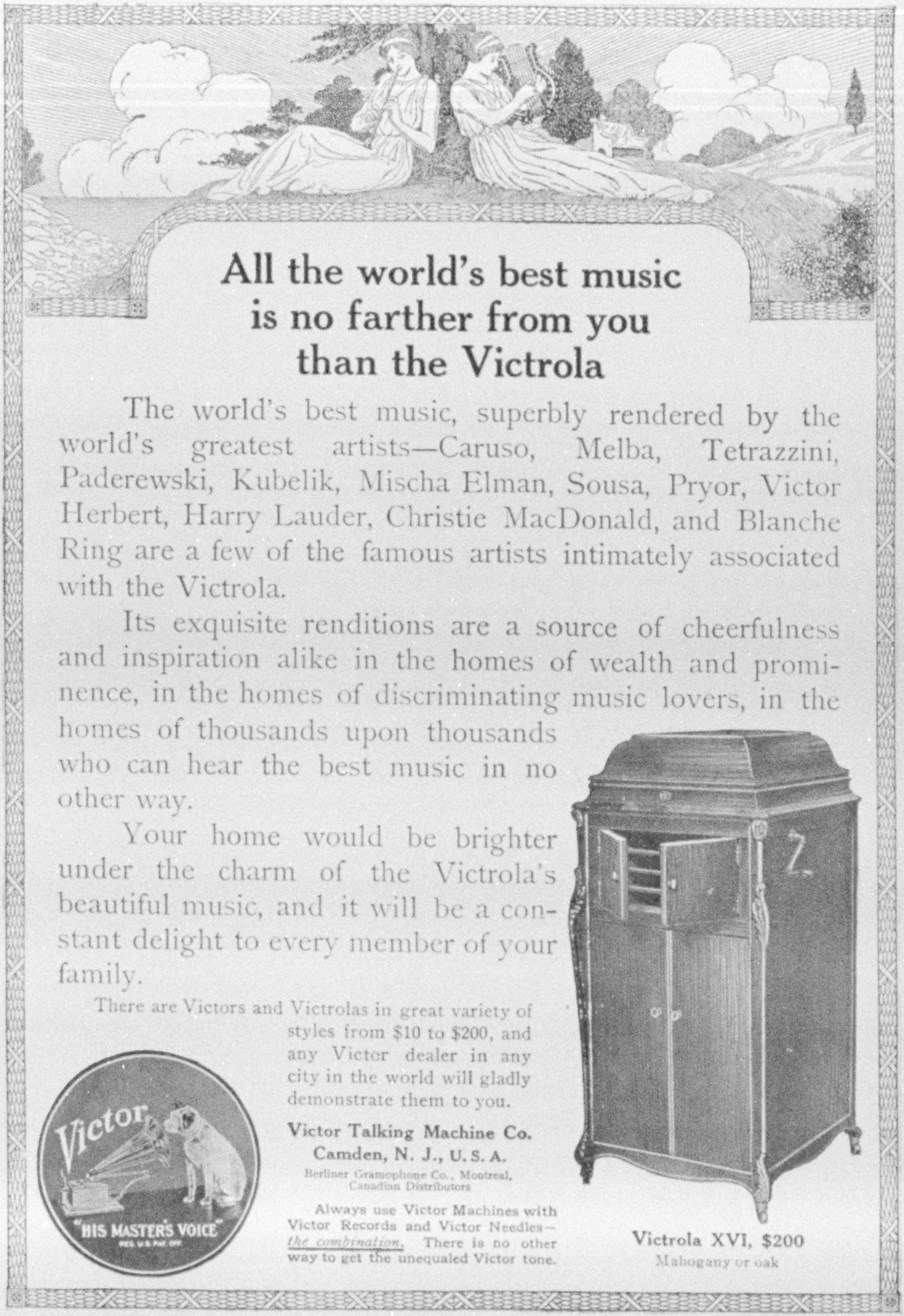

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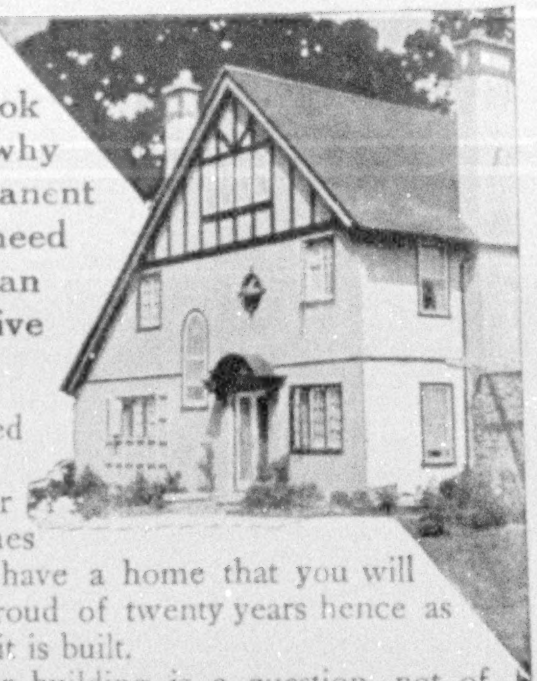

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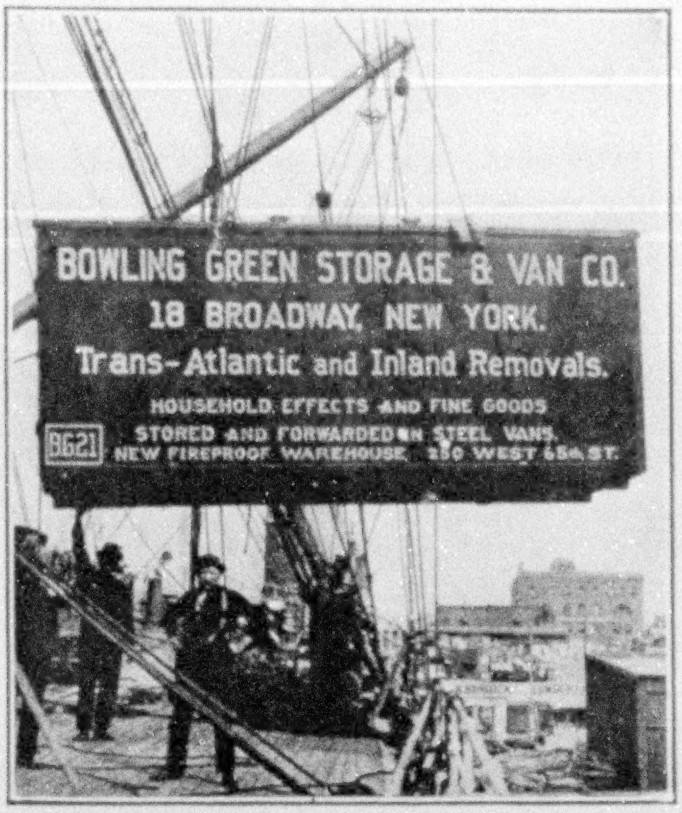
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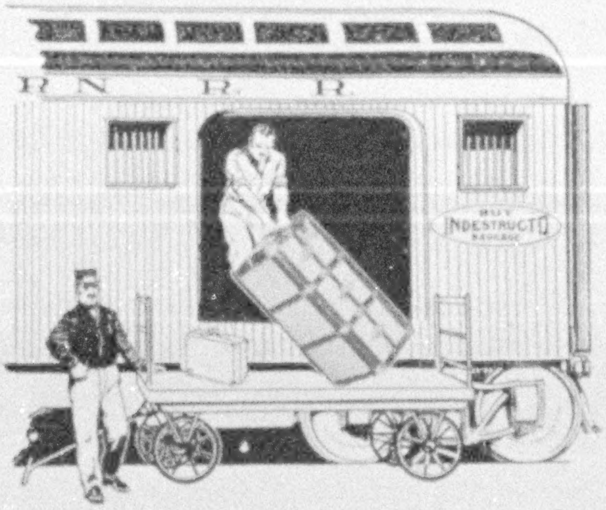

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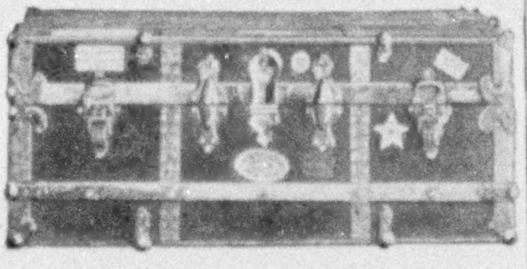

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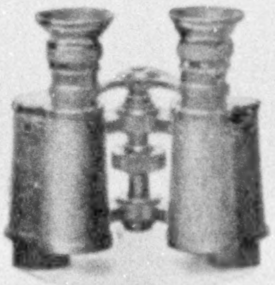

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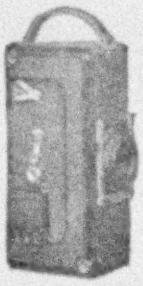

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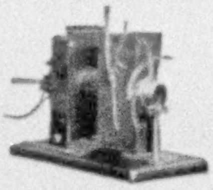

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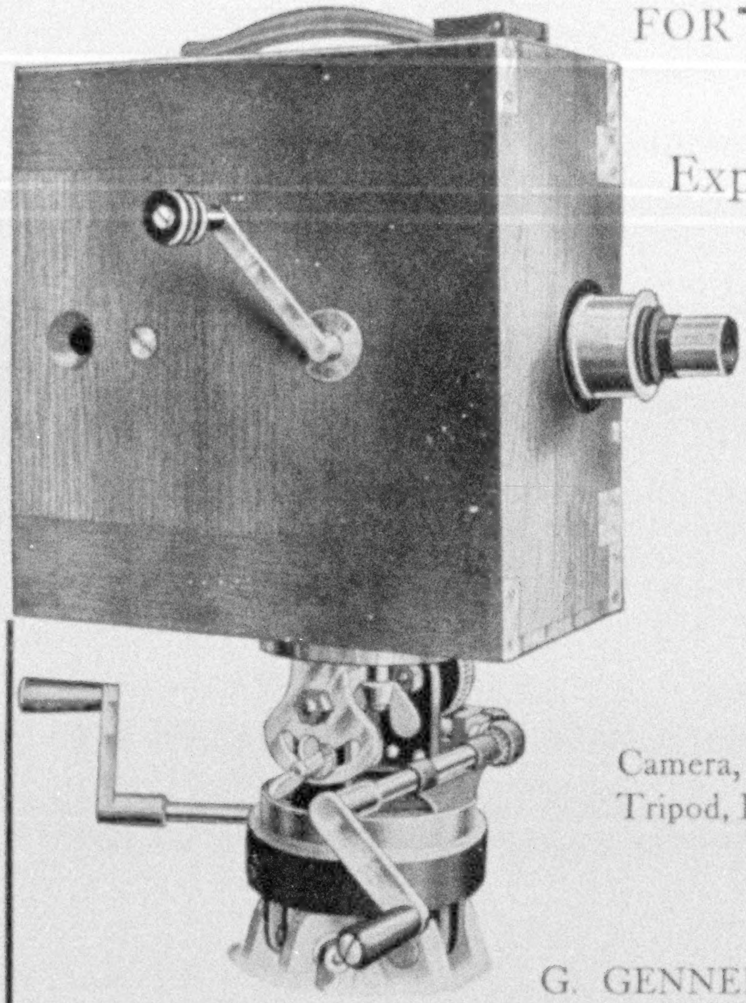

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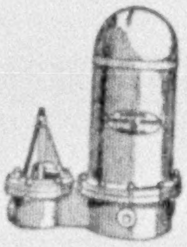

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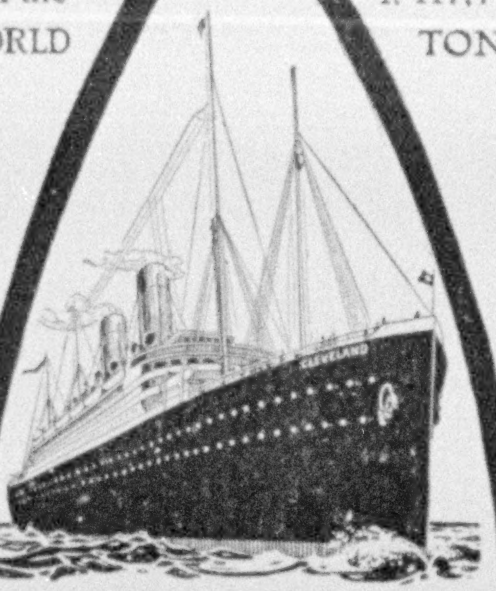

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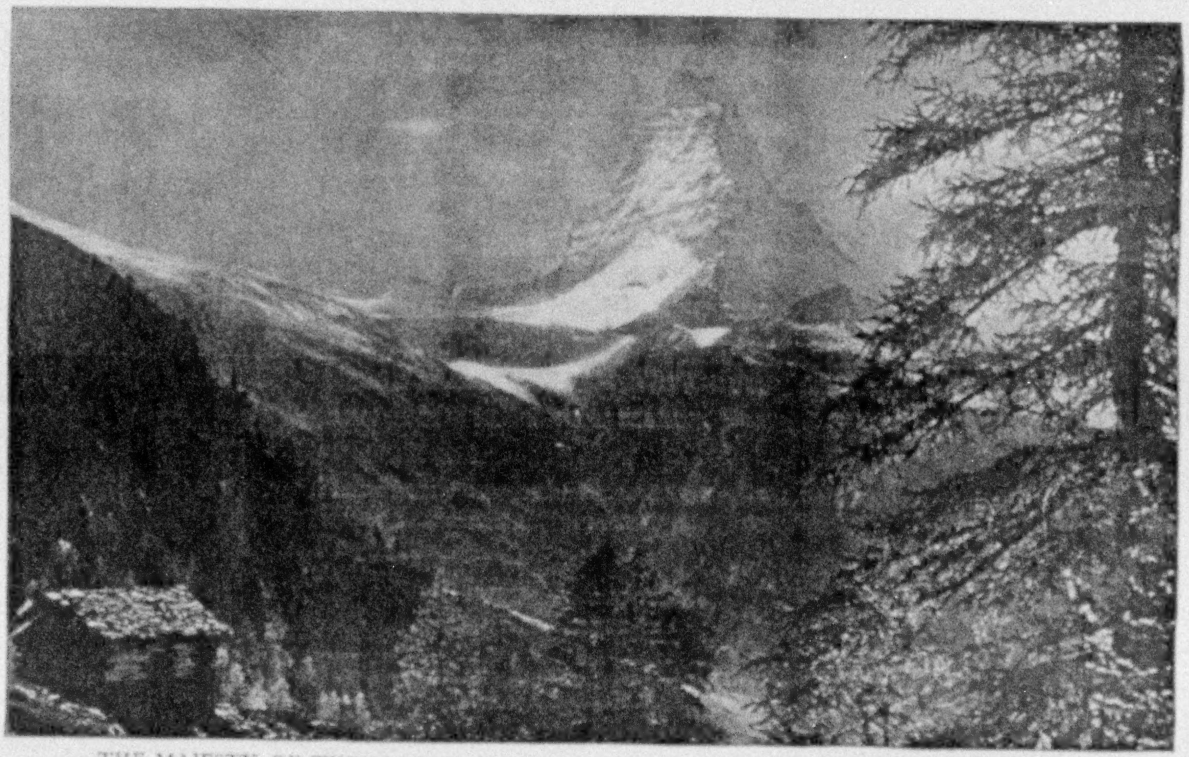

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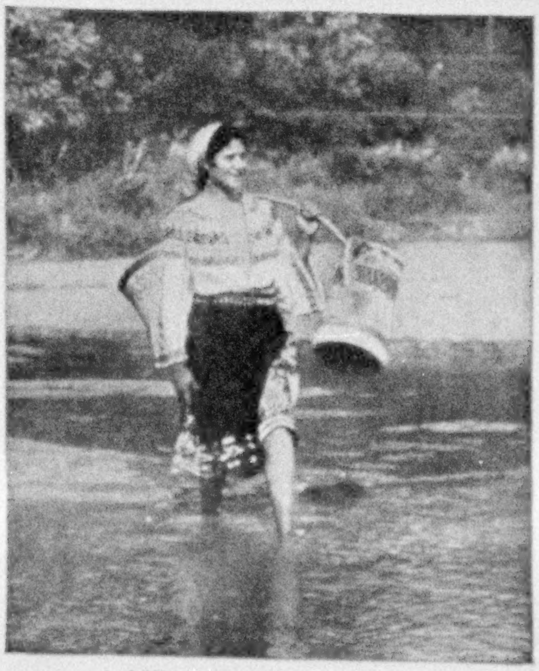

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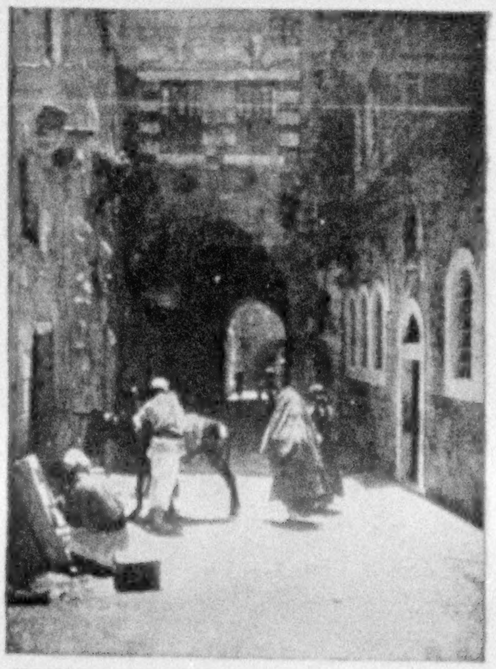

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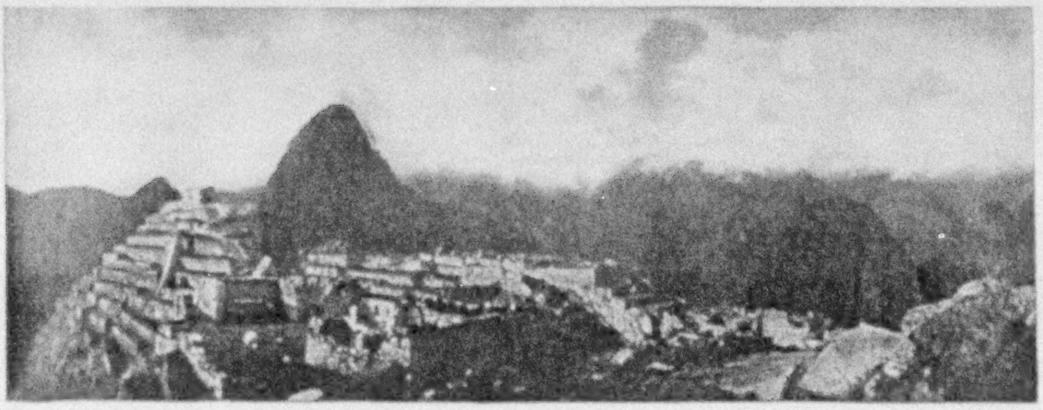

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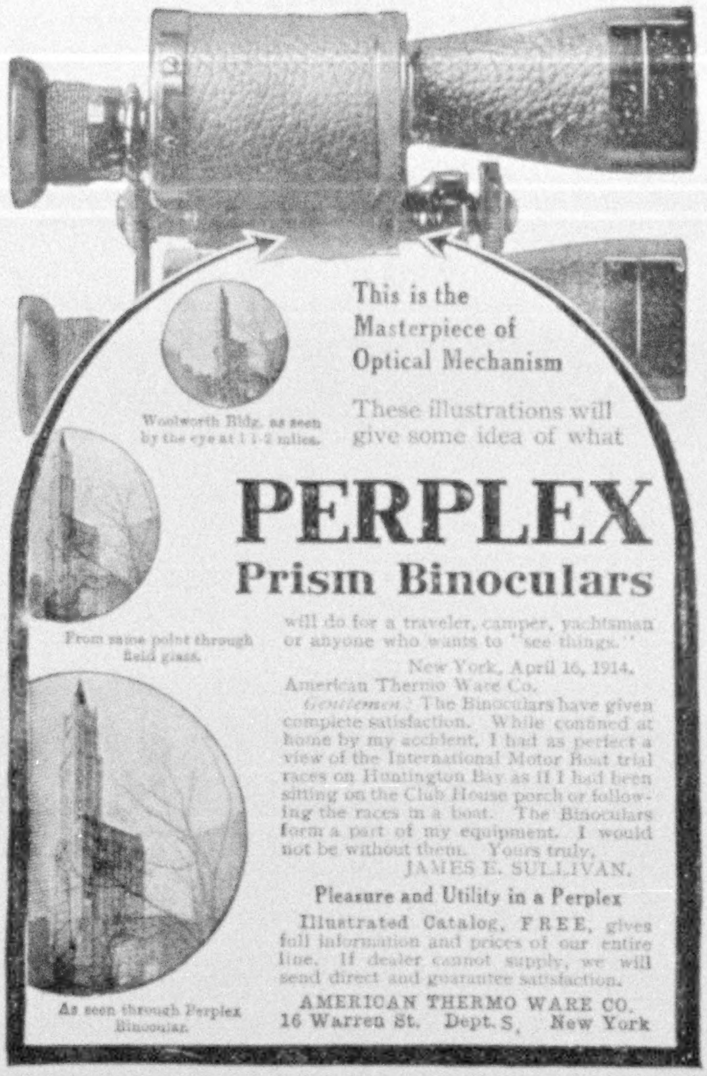

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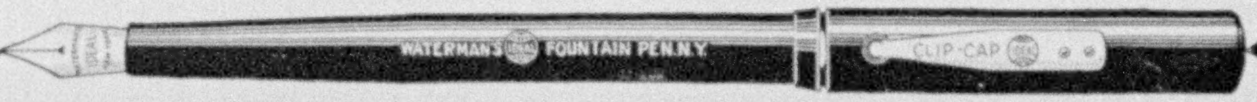

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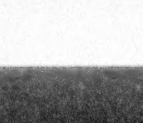

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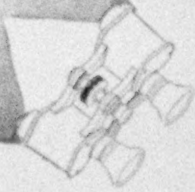

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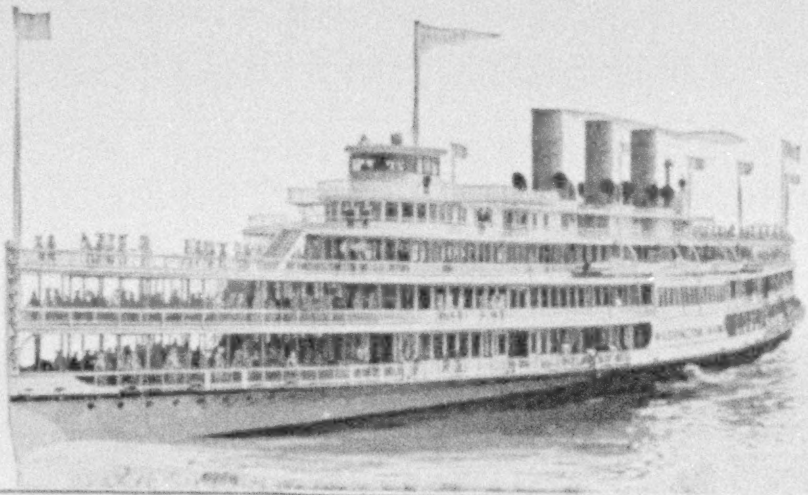

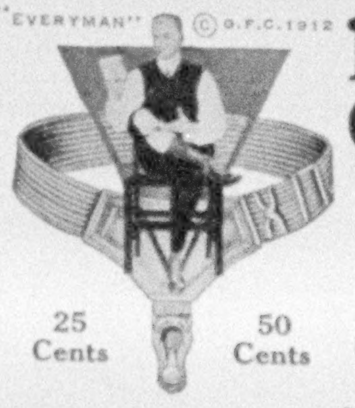

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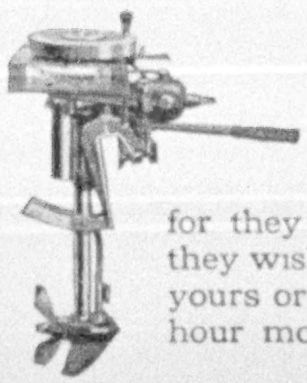

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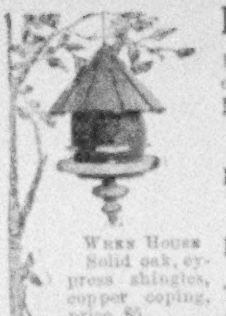

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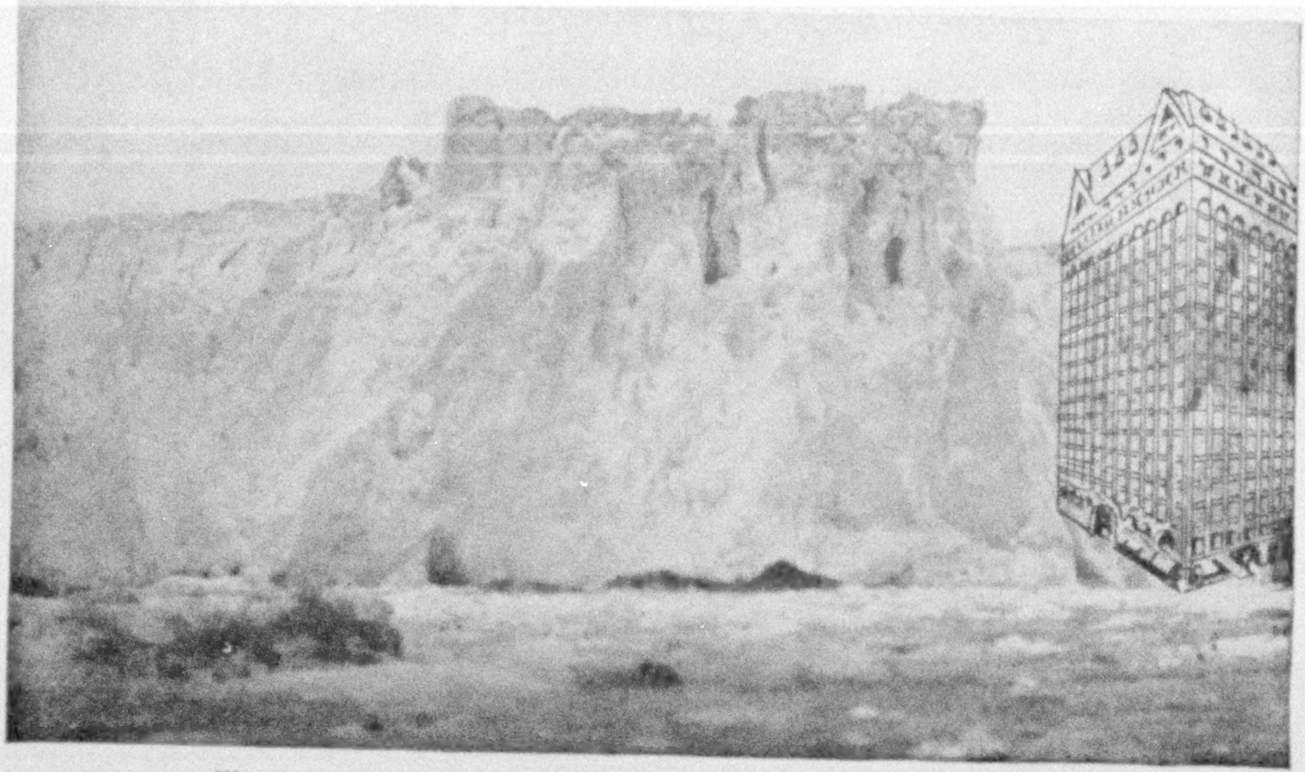

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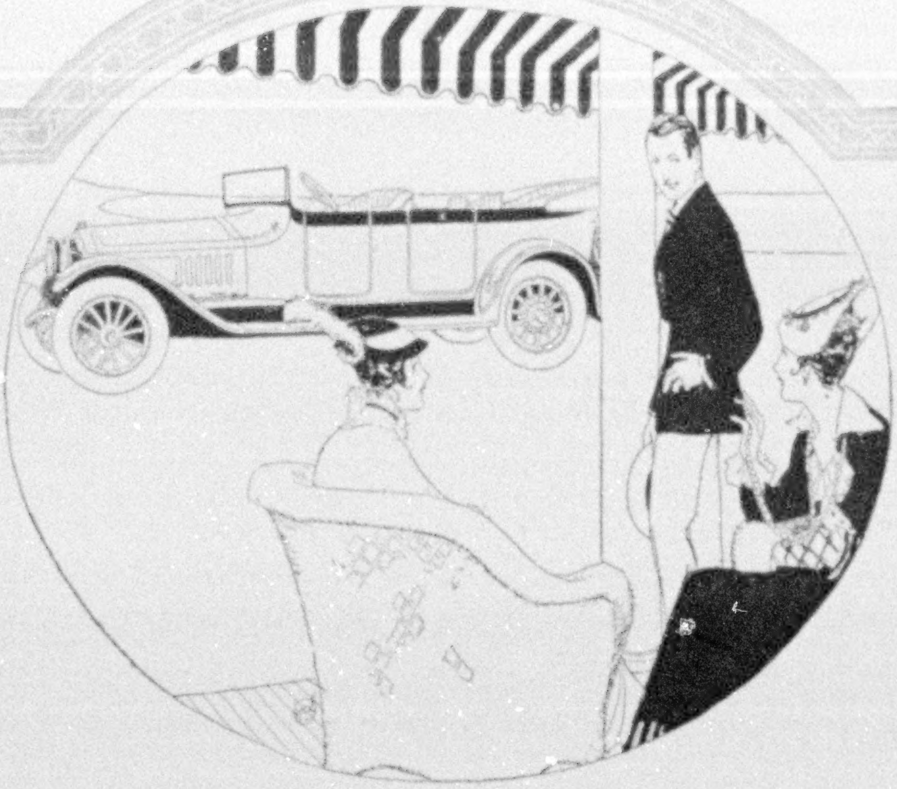

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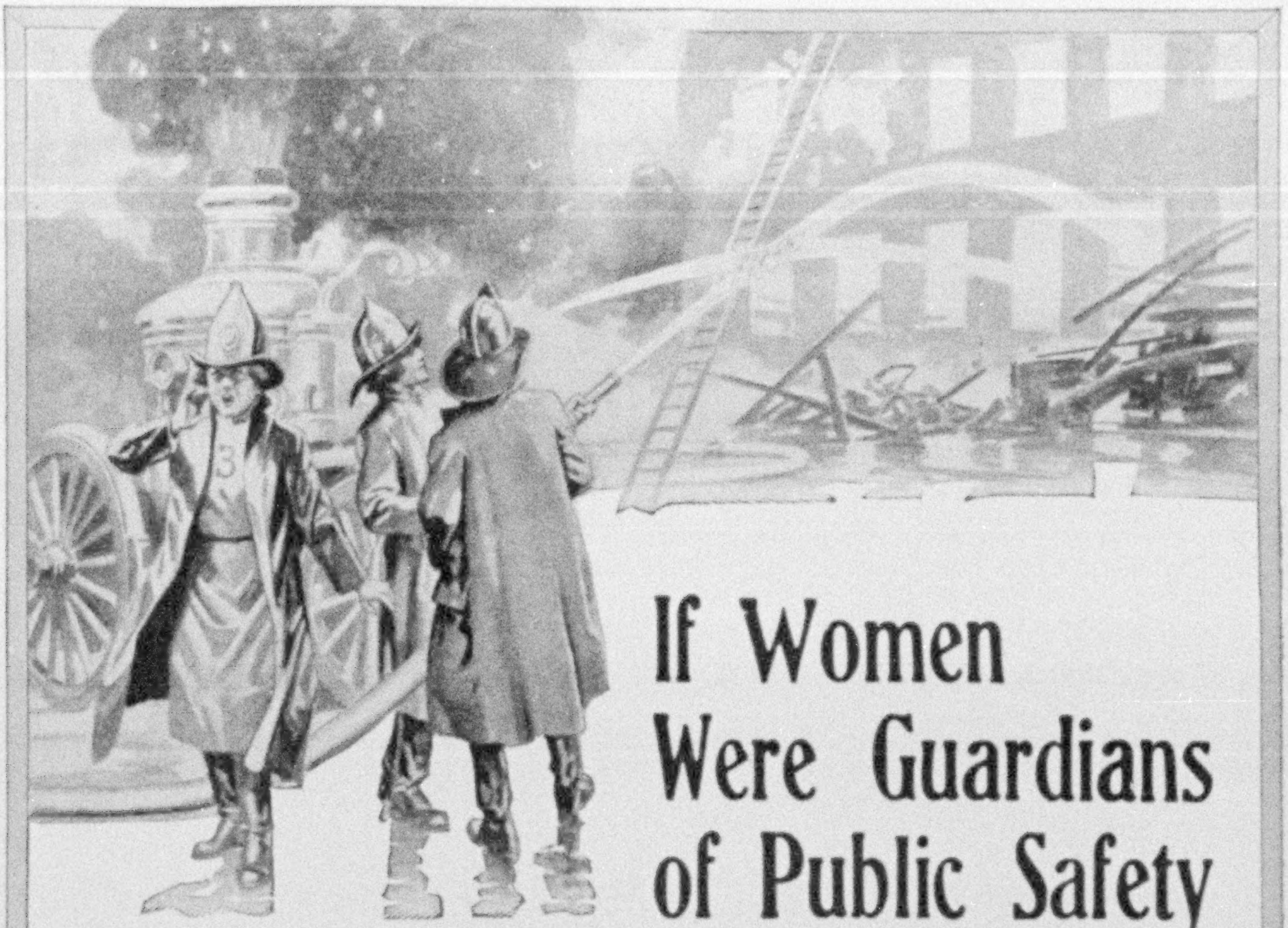

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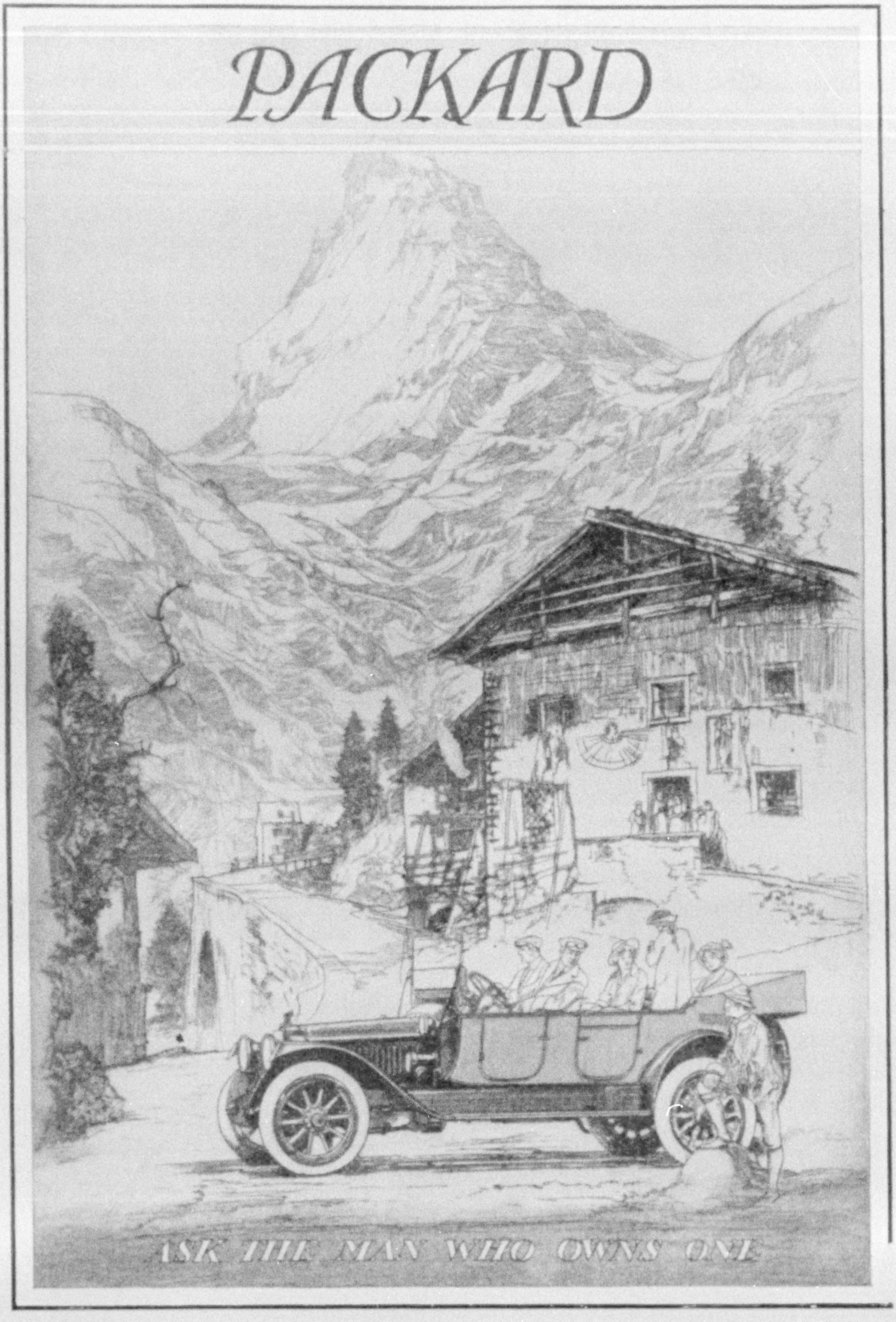
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